Forage Unit
Horticulture/Apiculture Unit
New Crop Development Unit

1998 Annual Report

Alberta
Agriculture, Food and
Rural Development

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Report of the Directors

S.F Blade, R.J. Howard and T.R. Krahn

The Crop Diversification Centres North and South (CDCN and CDCS) are research and development units of the Plant Industry Division of Alberta Agriculture, Food and Rural Development (AAFRD). They focus on applied research and technology transfer in support of the horticulture, special crop and forage industries. The Centres' mandate of crop diversification and industry development is achieved through close partnerships with commodity organizations, grower groups, agribusinesses, university, federal and private sector researchers, and individual producers and processors.

This Annual Report covers the activities of staff in the New Crop Development (including Apiculture), Horticulture, Forage, and Pest Prevention and Management Units located at CDCN and CDCS. In 1998, a significant change occurred in the administrative structure at both Centres. An open competition was held to recruit new Leaders for the New Crop Development, and Horticulture Units and to fill the Director positions at CDCN and CDCS. In September, Dr. Ron Howard was appointed Leader of the Horticulture Unit and Director at CDCS, while Dr. Stan Blade became Leader of the New Crop Development Unit and the Director at CDCN. Under this reorganization, administrative support, farm, shop and grounds staff at each Centre became the responsibility of the respective Directors. In addition, the Apiculture Program at CDCN was transferred from the Horticulture to the New Crop Development Unit. The Unit structure will continue to play a valuable role in facilitating planning of research, extension and industry development activities, while Centre-based budgeting and management should provide timely and efficient administration at each Centre. The strong leadership of both Centres provided by Tom Krahn during the first half of 1998 and the valuable role that he played during the transition period are gratefully acknowledged by Drs. Howard and Blade. Mr. Krahn has declared his intention to officially retired from government service on March 31, 1999.

The Horticulture Unit is responsible for programs dealing with fruit, greenhouse, nursery, potato and vegetable crops. The Unit also manages programs in plant pathology, entomology, micropropagation and market development, with specific responsibilities for the Alberta Vegetable Sales Act and Farmers' Markets. The Unit provides administrative and farm support to staff in the New Crop Development, Forage, and Pest Prevention and Management Units at CDCS.

The New Crop Development Unit is responsible for special crop research and development at CDCN and CDCS, as well as for plant pathology, weed science, post-harvest technology, food science, and soil and water agronomy support to the Horticulture and Forage Units at CDCS.

At CDCS, Forage Unit staff are involved in research and industry development related to the grass seed production, while staff in the Pest Prevention and Management Unit oversee the province's Dutch Elm Disease Prevention Program.

Staff of the New Crop Development Unit continued to play a strong role in both field research and technology transfer in support of crop diversification. In November 1998, the second Special Crops Conference was held in Edmonton. It featured a large number of national and international speakers, which drew a crowd of over 350 people. Staff in the Horticulture and New Crop Development Units assisted with the Alberta Horticultural Congress by serving on the organizing committee and acting as resource speakers and facilitators. Staff were also actively involved with several commodity groups, including the Potato Growers of Alberta, Alberta Pulse Growers Commission, Landscape Alberta Nursery Trades Association, Alberta Greenhouse Growers Association, Alberta Market Gardeners' Association, Fruit Growers Society of Alberta, Alberta Vegetable Growers (Processing), as well as with the Alberta Agricultural Research Institute (AARI) , the Canadian Horticultural Council, and several AAFRD product teams and committees. Staff of the two Centres organized and participated in several information sessions, workshops, field days and tours. At CDCN, large crowds attended a Special Crops Field Day on July 30, which featured all aspects of research done at the Centre. Vegetable growers who attended the Vegetable Field Day on September 16 at CDCS were able to review new production and agronomic techniques.

Budget restraint continued to require new and innovative methods of resourcing the operations at each Centre. In addition to careful stewardship of the line budget, several external funding projects were developed with AARI (Direct Funding and Matching Grants Programs), various commodity groups (pulse, potato, fruit, market gardens, etc.), private industry, and individual producers and processors.

This Annual Report is prepared as the summary of ongoing research and technology transfer programs at CDCN and CDCS. It represents the dedicated work of AAFRD staff who continue to play a major role in the development of the agricultural industry in Alberta and beyond. Additional information on any program area, including detailed research reports, is available upon request.

Forage Unit

H. Najda and A. Kruger

The grass seed and forage crops program at the Crop Diversification Centre South (CDCS) is part of the Forage Unit administered through the Lacombe Research Centre. The program conducts agronomic and adaptability research to provide up-to-date information on grass seed production and traditional forage crops. New crop species and varieties are submitted for experimental purposes by universities, research agencies and private industry in Canada, the United States and Europe. A small component of the program conducts cereal and oilseed testing.

Research involving over 100 irrigated and dryland trials were conducted at various locations in southern Alberta including sites at CDCS the CDCS Substation at Bow Island. Standard and producer fields near Tilley and Lomond, Alberta.

Several trials were conducted in cooperation with other research institutions and agencies. These include the Forage Unit, Lacombe Research Centre at Lacombe (forages), the Agriculture and Agri-Food Canada Research Station (AAFC) at Swift Current (triticale co-op), and the Field Crop Development Center (FCDC) at Lacombe (cereals and oilseeds).

The program leader also provides information services to other AAFRD staff and to producer and commodity organizations. Details of research trials are presented in *Grass Seed and Forage Crops Program Annual Report 1998*, CDCS Pamphlet 99-9.

Research Projects

Perennial Forage Crop Studies

Perennial grass seed production under irrigation

This has become a major area of research in southern Alberta. Many seed companies from the United States and Europe are now contracting production acres in Alberta under irrigation and dryland. Agronomy trials on Kentucky bluegrass, tall fescue, fine-leaved fescue and perennial ryegrass were conducted at Brooks and Bow Island. These included companion cropping studies, fertility trials, dates of seeding and row spacing trials.

In 1998 the Western Grass Seed Testing Program (WGST) was initiated to provide seed yield and adaptability information to the seed industry. The trials are coordinated by the grass seed and forage crops program at CDCS and are a cooperative effort of the federal and provincial governments and the seed industry. Testing sites are located at Fort St. John, British Columbia; Beaverlodge, Bow Island and Brooks, Alberta; Melfort and Outlook, Saskatchewan; and Arborg and Portage La Prairie, Manitoba. The grass seed and forage crops program at CDCS is responsible for seed acquisition and distribution to test cooperators and production of an annual report for seed producers and the seed trade. Species currently being tested are meadow, slender, hard, tall, sheeps and red fescues, Kentucky bluegrass, perennial ryegrass, smooth bromegrass, orchard grass and bentgrass.

Perennial forage variety testing

This was the eighth production year of the province-wide program evaluating perennial forage species and varieties which is funded by Alberta Agriculture, Food and Rural Development (AAFRD) and coordinated by the Forage Unit, Lacombe Research Centre. Species tested include alfalfa, bromegrass, the wheat grasses, timothy and orchard grass. The grass seed and forage crops program, at CDCS, is responsible for conducting trials at three dryland (Bow Island, Brooks and Standard) and two irrigated (Bow Island and Brooks) sites. The grass seed and forage crops program at CDCS compiles and analyses data from all the

provincial sites and prepare the annual report for the Alberta Forage Variety Committee (AFVC) of the Alberta Forage Council. This testing program provides information that allows producers to base crop decisions from a wide range of forage varieties tested. Data have indicated that there are significant differences in variety performance from one area of the province to another. Results of the trials are now available to the producer in the updated Agrifax pamphlet *Varieties of Perennial Hay and Pasture Crops for Alberta*, Agdex 120/32. This information is also available on the Internet at the AAFRD site: http://www.agric.gov.ab.ca

The Western Forage Testing Program (WFT) was initiated in 1995. This is a tri-province (Alberta, Saskatchewan and Manitoba) cooperative venture which tests forage varieties for registration purposes. Information generated from this trial testing program will provide a basis for registration and in most cases, enough location years to provide data for particular agro-climatic areas. This efficiency will eliminate a minimum of four years testing over previous testing programs. In 1998, thirteen alfalfa varieties, two timothy varieties and one variety each of alsike clover, tall fescue and orchard grass were supported for registration by the AFVC.

Cereal and Oilseed Cultivar Evaluation

Cereal and oilseed regional tests

Trials coordinated by the Cereals and Oilseeds Unit at the FCDC at Lacombe and funded by AAFRD are used to evaluate all currently used cultivars, new cultivars, and breeding lines of hard red spring wheat, durum wheat, utility wheat, barley, oats, triticale, flax, and canola. The grass seed and forage crops program is responsible for an irrigated site at Brooks. Information from these trials conducted at sites province-wide is used by the Cereal and Oilseed Advisory Committee to annually update the factsheet *Varieties of Cereal and Oilseed Crops for Alberta* Agdex 100/32. This was the last year of our participation in this program.

Other cereal trials

The grass seed and forage crops program cooperates with the Cereals and Oilseeds Unit at the FCDC at Lacombe, in their breeding programs for two-row and six-row barley, semi-dwarf barley, triticale, winter triticale, and winter wheat. The progeny and advanced line tests provide agronomic data used for the registration of varieties suitable for irrigated areas. Triticale grain trials are conducted under the Prairie Registration Recommending Committee on Grain Testing program, which is coordinated by the AAFC Research Station at Swift Current, Saskatchewan. This was the last year of our participation in this program.

Technology Transfer Services

The program leader provides extension service to growers and industry personnel. In 1998, presentations were made at several industry and producer meetings and provincial advisory committees. Two information pamphlets on forage variety performance were updated.

The program leader participated on the Forage Product Team, the Alberta Forage Variety Committee, the Forage Association Grant Committee, the Alberta Alfalfa Seed Committee, the Western Grass Seed Testing Committee, the Western Forage Testing Committee, the Agriculture Technology Advisory Committee of the Lethbridge Community College, the Strategic Change Steering Committee and the board of the Chinook Applied Research Association. The program leader also participated in seed judging for the North American Seed Fair held at Ag-Expo, Lethbridge.

Horticulture/Apiculture Unit

Alberta Dutch Elm Disease Initiative

J. Feddes-Calpas

Alberta is one of the few places in the world with large populations of American elm trees that are free from the scourge of Dutch elm disease (DED), a highly destructive fungal disease. Alberta's DED-free status is in large part due to the hard work done by the Society to Prevent Dutch Elm Disease (STOPDED), AAFRD's Dutch Elm Disease Initiative (DEDI), and the many individuals involved in the DED Action Committee, the forerunner of STOPDED. Since its introduction from Europe in 1930, DED has destroyed millions of American elm trees across North America. Large population of elms, valued at over 500 million dollars, grow in Alberta's urban areas.

STOPDED is a non-profit organization, which was formed in Alberta in 1993. Members include provincial and municipal staff, nurserymen, landscapers, arborists, research scientists and concerned Albertans. The common principle uniting all of these individuals is a desire to preserve and protect these stately trees.

Without a province-wide DED prevention program in place, Alberta runs the risk of sustaining a significant impact on the elm population if and when DED strikes. Based on cost analysis performed in areas fighting DED, evidence shows that if a prevention program had been in place billions of dollars would have been saved. A program includes: having a site-specific elm inventory completed, monitoring elm bark beetles (the vectors of the DED fungus), detection of DED, elm firewood control, elm sanitation, removal of dead elms and elm stumps, and public awareness.

In 1996, Alberta's Critical Pest Response Team evaluated the situation regarding the introduction of the smaller European elm bark beetles (SEEBB) into the province and the associated threat posed by the beetle as a vector of DED. The Team determined that the Alberta Pest Infestation Response Plan was to be activated for DED. This decision prompted increased funding to go towards the DEDI.

STOPDED has been cooperating with various federal and provincial agencies led by AAFRD. In March of 1997, STOPDED received funding from Human Resources Development Canada (HRDC), to provide new and sustainable employment opportunities within STOPDED's prevention program. As a result of this funding, STOPDED and each of the larger municipalities, hired personnel to complete a province-wide elm inventory and increase public awareness of the threat of DED. AAFRD and these larger municipalities have contributed in-kind service to complete this job.

It is the Society to Prevent Dutch Elm Disease (STOPDED) along with AAFRD's goal to complete a province wide elm inventory in all of the Alberta communities by March 31, 1999. This is done to estimate the geographical distribution, populations and value of elms in Alberta. A site specific elm inventory supplies the basic information necessary for an effective management program should DED appear in Alberta. Information such as species, location, size, and condition of the elms is collected.

Inventory in 90 percent of the communities in the province has been completed. It has been found that municipal plantings of elms range from 10% to 50% of the overall tree plantings, often with comparable numbers growing on private lots.

The DEDI has overseen the design of a user-friendly computerized elm tree inventory program funded by AAFRD. This program will allow each community to use the data to create management tools for the care of their elms. Along with a CD-ROM or hard copy of the inventory data, recommendations will be sent to each community on how to set up a DED prevention program.

DEDI along with some of the larger municipalities have monitored for the DED fungus vectors, the smaller European elm bark beetle (SEEBB), and the native elm bark beetle (NEBB), since 1978. The Beetle Monitoring Program is an important component to a DED prevention program and is done to determine if either vector is in the province. Since 1993, the DEDI has consistently increased the monitoring locations from 35 to 164 locations. These locations included smaller municipalities, nurseries, provincial parks and

all ports-of-entry. Monitoring season for the vectors is between April 1-Sept 30 using pheromone baited sticky traps. In 1998, a total of 474 traps were set up throughout the province by DEDI and the larger municipalities. Many additional municipalities have shown an interest in the trapping program.

SEEBB have been captured for the fifth year in Calgary, fourth year in Edmonton and for the first time in Medicine Hat at record numbers. One SEEBB was captured in St. Albert. Previously, beetles had been found in St. Albert in 1995, 1996. SEEBB were found throughout Calgary, Edmonton and Medicine Hat with totals of 142, 13, and 21, respectively. SEEBB have been captured in Vauxhall in 1996 and in High River in 1997.

If DED is found early enough in the community, many of the elms can be saved. The most opportune time to detect DED is from mid-July to the end of August when typical symptoms relating to the disease can be seen.

To date there are no confirmed reports of DED in the province. In 1998 a total of 32 elm samples from throughout Alberta have been cultured for the presence of the DED fungus (*Ophiostoma ulmi*) by Dr. J.P. Tewari, at the University of Alberta. A culture of a fungus recovered from a suspect tree was sent to a lab in England in order to obtain another expert opinion on the identity of the pathogen. Results are pending.

Research on DED control is continually being done. Dr. Martin Hubbes from the University of Toronto's Faculty of Forestry has been working with *Ophiostoma ulmi* for the past 25 years. Dr. Hubbes and his research team has developed a vaccine that appears to successfully arrest DED. This vaccine has been called the "elicitor" since it elicits a defensive reaction in the elm tree's natural immune system. This is the second year DEDI has been part of a field trial to test the effectiveness of this biochemical treatment.

The DEDI's physical presence and active involvement in communities across the province will have a long-lasting effect on Albertans' dedication to a DED-free Alberta. The DEDI's efforts have contributed greatly to public awareness of the seriousness of a DED outbreak. STOPDED employees have traveled to every municipality in the province taking inventory and increasing public awareness. Local parks departments and administrations have been met to discuss DED and given a package which includes the DED response plan. Public information sessions were conducted featuring a STOPDED video, displays, and printed information about the disease. Elm trees have been identified in the municipalities and owners presented with detailed information about DED.

A Dutch Elm Disease Awareness week was proclaimed by the Minister of Agriculture, Honorable Ed Stelmack and will be an annual event. It was celebrated by municipalities across the province from June 1-5. The STOPDED video was aired on several television stations across the province and shown to various groups. Displays were set up, trees were wrapped with yellow awareness tape, presentations were made and the media contacted during the week. An article published on DED by the Agrinews was picked up by local papers and radio stations. Several municipalities also had a elm tree planting ceremony and a number of grade six schools participated in a DED poster contest.

The provincial DED hot line based out of CDCS has been extensively used throughout 1998.

With the progress DEDI and STOPDED have made in the province-wide DED Prevention Program, Alberta now has a solid foundation to work towards dealing with DED, if and when it is found, and to keep tree losses to a minimum.

Apiculture Program

K. Tuckey and D. Colter

The apiculture program of Alberta Agriculture, Food and Rural Development provides extension and regulatory service to the beekeeping industry of Alberta. Offices are maintained in Edmonton and Falher.

Apiculture registrations 1998

The Alberta Bee Act requires people who own and possess honey bees or beekeeping equipment in Alberta to register, annually, the number of colonies they own and the municipalities in which their bees are located (Tables 1, 2 and 3). The large number of beekeepers shown in Regions 2 and 4 reflects, in part, the number of hobbyist beekeepers living in Calgary and Edmonton.

The relatively large number of colonies in Region 1 reflects the honey bee colonies needed to service the hybrid canola seed production industry in that area.

Table 1. Number of beekeepers and colonies.

Region*	1997		1998***	
	Beekeepers	Colonies	Beekeepers	Colonies
N R**	3	1602	4	3409
1	66	42855	74	53950
2	136	9600	146	11810
3	94	23108	99	26422
4	256	47920	275	55677
5	111	49326	123	53593
TOTAL	666	174411	721	204861

* Region as established by Alberta Agriculture, Food and Rural Development
** NR means non-resident beekeepers who operate colonies in Alberta
*** as of December 31, 1998

Table 2. Number of Beekeepers - by Region and Size of Operation.

Colonies operated	Number of beekeepers per region* 1998***						
	NR**	1	2	3	4	5	Total
0	-	13	32	11	56	9	121
1-50	1	38	93	59	154	43	388
51-600	1	9	18	13	40	38	119
601+	2	14	3	16	25	33	93
Total	4	74	146	99	275	123	721

* Region as established by Alberta Agriculture, Food and Rural Development
** NR means non-resident beekeepers who operate colonies in Alberta
*** as of December 31, 1998

Table 3. Bee Colonies Operated - by Region and Size of Operation.

Size of operation	Number of colonies per region* 1998**						
	NR**	1	2	3	4	5	Total
1-50	9	458	970	559	1297	428	3721
51-100	100	232	492	-	760	1201	2785
101-200	-	130	635	910	1967	1411	5053
201-600	-	2115	3563	2189	7381	5173	20421
601-1250	-	4265	-	6730	12177	20730	43902
1251-2000	3300	3000	3350	10634	5590	8060	33934
>2000	-	43750	2800	5400	26505	16590	95045
Total	3409	53950	11810	26422	55677	53593	204861

* Region as established by Alberta Agriculture, Food and Rural Development
** NR means non-resident beekeepers who operate colonies in Alberta
*** as of December 31, 1998

Alberta beekeepers placed those 205,000 colonies in 6,541 beeyards or apiaries. Most of these beeyards are on land owned by someone other than the beekeepers and in most cases the landowners receive a "rent" of about 30 pounds of honey for the inconvenience of having bees on their property.

Economics of beekeeping

The price of raw bulk honey reached a record high of about $1.25/lb in 1996. During 1997 the price decreased to $1.00/lb. The 1998 extracting season started with honey prices at $.90/lb and the price decreased to about $.80. With the large honey crop there was an early movement of honey into the export market, particularly to Europe.

The demands of the hybrid canola seed production industry in southern Alberta continue to exercise a major influence on Alberta beekeeping. In 1998 at least 40,000 colonies were devoted to hybrid canola seed production. This is reflected in Table 1, which shows a small number of beekeepers and a very large number of colonies in Region 1. As demand for honey bees increases beekeepers from further afield are being attracted to this venture. The rental rate per colony stays competitive with the normal returns from honey production. Even though the seed companies are also using leafcutter bees it appears that there will be a need for even more colonies of honey bees in 1999 - at least one of the companies was actively recruiting beekeepers at the Alberta Beekeepers' Association annual convention.

Alberta honey production 1998

Except for one or two small areas, beekeepers throughout the province benefited from ideal conditions and produced honey crops that were of good average or excellent size. The survivability over the winter was better than normal and the number of honey bees in the colonies in the spring was greater than normal. The "soft" winter lead into an early spring that favoured honey bees. The total number of colonies in the province was up sharply as beekeepers took delivery on bee stocks they had ordered earlier to replace anticipated losses. As well colony numbers increased as beekeepers split their colonies in order to prevent swarming.

The main honey flow started earlier than normal and in many areas lasted much longer than normal. As a result it is forecast that the average honey production will be at least 160 pounds per colony for a total crop of 32,000,000 pounds. It must be noted that the 40,000 colonies on canola production produce significantly less honey than other colonies. Colonies run for honey production averaged at least 200 pounds per colony.

Figure 1: Alberta Honey Production (Millions of Pounds)

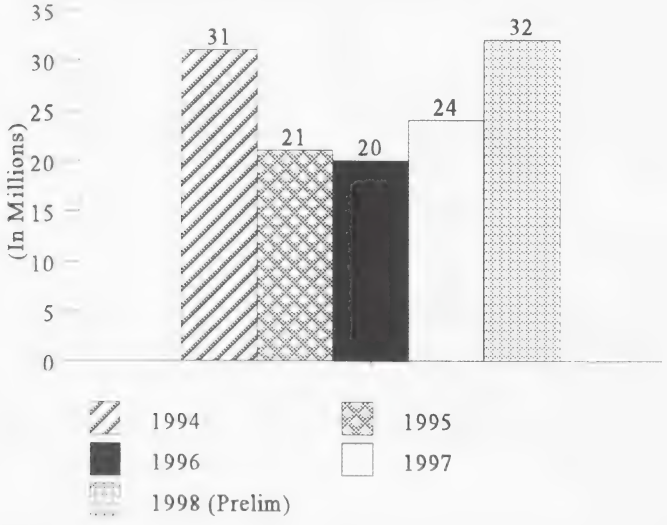
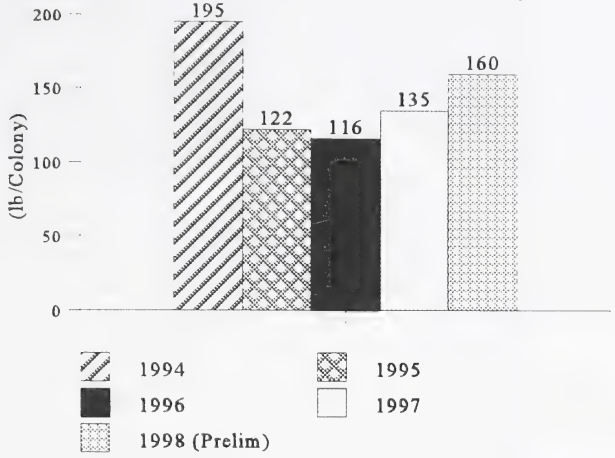


Figure 2: Alberta Average Honey Yield (lb/colony)



Apiculture inspections and surveys

As varroa mites are found in more beekeeping operations, beekeepers are becoming more aware of the need to test their own bees for the presence of parasitic mites. The original Alberta varroa mite findings (1993 & 1994) were in operations that received honey bees directly from British Columbia. Since 1995 varroa mites have been established in the permanent bee population. The spread of varroa continued in 1998.

A survey form on honey bee parasitic mites went out to all beekeepers with the beekeeper registration forms. The information from the surveys gave a good idea of the spread of these mites in Alberta and their effect on the industry.

By the end of 1998 varroa mites had been identified in 80 beekeeping operations in 52 rural Alberta municipalities. Those 80 beekeepers operate approximately 98,000 colonies. However, not all bee colonies in each of those operations or municipalities, nor even most of them, are positive for varroa. Varroa mites have been identified through most of the province except for the St. Paul area and the east side of the province almost as far south as Medicine Hat.

Honey bee tracheal mites are known to be in 200 operations covering roughly the same part of the province as the varroa mites.

The beekeepers who responded to the survey indicated that other than the cost for material and labour to combat the mites they find few significant effects of the mites on their operation.

In order to enable movement, varroa checks were made on all operations moving bees to British Columbia for the winter. In addition, a survey was made of beekeeping operations adjacent to previous varroa finds. From inspections made and from information received from the survey 40 beekeeping operations were added to the varroa positive list. In most cases the levels of infestation appear to be quite low.

Most hive inspections carried out were at the request of owners - either to facilitate the sale of equipment or because the beekeeper perceived a problem. Colonies and/or equipment in nine beekeeping operations were examined specifically for brood diseases. American Foulbrood (a bacterial disease) was detected in one operation. The inspections were not widespread enough to give an indication of the health of the whole industry. However, it is clear that beekeepers who do not monitor and control this disease can have a problem develop quickly.

Interprovincial movement of honey bees

A permit is required from Alberta Agriculture, Food and Rural Development to move Canadian honey bees into Alberta. Also regulations require that all bees coming into Alberta from provinces known to have varroa mites must be treated for the control of the mite prior to entry. A number of shipments were checked to confirm compliance with this regulation.

During the spring of 1998 permits were issued for the importation of 10,500 colony units (packages, nucleus or full size colonies) into Alberta from British Columbia and Saskatchewan. In the fall 7,700 colony units moved to British Columbia for the winter season.

The number of colonies moving to British Columbia decreased significantly because of the decision of one major beekeeper. Not withstanding this decrease, the continued advance of varroa mites through Alberta improves the feasibility of wintering in British Columbia. Once beekeeping operations are infested with varroa, there is less to lose by coming in contact with varroa infested bees - the beekeepers are already committed to the expense of treating all of their colonies to prevent loss from the mites. The beekeepers can then take advantage of the mild southern British Columbia winters with their varroa positive bees.

Overwintering honey bees

Alberta beekeepers continue to winter their honey bees in British Columbia, in ventilation controlled buildings or outdoors. Bees are wintered in a number of formats. The most common way is as two brood chamber colonies outdoors but a few beekeepers utilize three supers outside. Bees that are wintered indoors or in British Columbia may be one or two brood chamber colonies or nucleus colonies (nucs) with only five or six frames. Table 4 provides wintering statistics for recent years.

For two years now beekeepers have been providing information on whether their bees were wintered indoors or outdoors. Table 4 shows data based on those years plus the previous three years.

Table 4. Winter Survival of Honey Bee Colonies

Year	Colonies operated *	Units into winter	% Survival
1993-1994	157,000	149,000	81
1994-1995	166,000	161,000	81
1995-1996	180,000	174,000	69
1996-1997	164,000	In 64,000	82
		Out 102,000	80
1997-1998	174,000	In 55,000	87
		Out 117,000	89
1997-1998	205,000#	200,000#	N/A

* indicates the number of colonies operated prior to the winter
# estimate

Government Programs

Agriculture Financial Services Corporation - Insurance Division - This joint Federal, Provincial and industry program continued to protect 29 Alberta beekeepers from losses due to poor honey yields compared to their long-term average yield. Three beekeepers made claims against the programme for $406,000 compared to the poor honey crop of 1997 which resulted in 11 loss claims for $919,000. This programme has experienced significant losses for two years in a row and is currently being reviewed.

Net Income Stabilization Account (NISA) - This joint Federal, Provincial and industry program, which assists farmers to provide long term monetary security for their farms, was first offered to beekeepers in the 1992 taxation year. During the 1995 taxation year 89 beekeepers made contributions based on net sales of $11.8. In 1996 71 beekeepers made contributions on $6.4 million The programme continued to be popular with beekeepers for the 1997 crop year when 106 beekeepers made contributions on net sales of $10,600,000.

Farming For The Future and On Farm Demonstration Program - These provincially funded programs assist in basic and applied research and in proving the worth of new ideas on the farm. From time to time beekeeper related subjects are tested.

Statistics - Each year the Production Economics and Statistics Branch of Alberta Agriculture, Food and Rural Development do a survey of beekeepers to determine the crop received and other data about the Alberta beekeeping industry. This information is forwarded to Statistics Canada and included in country-wide figures. As well the same section periodically collects data on the economics of the industry. These are published as Agdex # 821-62. The latest compilation was for the 1995 crop and a new one (which will include pollination for hybrid canola seed production) is being done on the 1998 season.

The Canada - Alberta Farm Business Management Initiative - published a profile on the "Commercial Honey Industry" in their Agventures Series - Agdex # 616/830-1.

Technology Transfer Services

Both apiculturists provide monthly articles to the *Bee News*, published by the Alberta Beekeepers' Association. Talks were given to the annual meeting of the Alberta Beekeepers' Association and to local beekeepers meetings upon request.

A large part of any summer office time is used providing advice to members of the public who have called with "honey bee" problems. At least half the time the insects involved are bumble bees or some type of wasp.

Beekeepers and potential beekeepers consult the apiculturists on a regular basis requesting information or service.

Interpreting the beekeeping industry to other segments of the government, and to industry, is an important facet of the duties of this section.

Entomology and Micropropagation Program

K. Pruski, J. Motta and T. Lewis

The entomology program completed its first year of operation in 1998. It provided growers of horticultural crops in Alberta with extension and applied research in the areas of insect control and integrated pest management (IPM). The program established contacts with entomologists from other prairie provinces and across Canada, and actively participated in IPM research. Being still "under construction", the program focused on preparation and delivery of extension services to Alberta growers and on organization of the entomology laboratory. An insect collection has been initiated and several insect surveys were completed. The goal of the program is to increase the skills and knowledge of horticultural crop producers to recognize pests and to apply proper pest management techniques.

The micropropagation program was focused on germplasm storage/maintenance, tissue culture research and extension. Due to privatization, the program was reduced to the necessary minimum of providing growers with mother stock cultures and information.

Tissue culture plant material available at CDCN during 1998 included:

Species	Cultivar
chokecherry	Garrington, Goertz, Robert, Lee Red, Yellow Boughen
Mongolian cherry	#2, #4, Beaverlodge selections
Nanking cherry	Black, White (Lee orchard)
pincherry	Liss, Jumping Pound, Lee #1, 2, 3, 4
raspberry	Wyoming (black), Redbrook, Fallbrook
saskatoon	Altaglow, Beaverlodge, Bluff, Buffalo, Forestburg, Honeywood, Lee #3, 5, 8, 10, 11, 12, Martin, Moonlake, Nelson, Northline, Pasture, Parkhill, Pearson II, Pembina, Quaker, Regent, Smoky, Success, Thiessen
sour cherry	Lutowka (Schattenmorelle) and Evans

Research Projects

Integrated pest management approach in control of root maggots in cabbage crops in Alberta

The project was done in co-operation with vegetable program at CDCN. The main goals of the project were: 1) to determine the root maggot life cycle in central Alberta, 2) to evaluate the efficacy of an entomopathogenic nematode *Heterorhabditis megidis* against root maggots in cole crops, and 3) to evaluate the effectiveness of the insect repellent "Garlic Barrier" in reducing root maggot infestation. Data from the 1998 growing season clearly showed two outbreaks of root maggot flies, with highest populations around June 11 (50 flies per trap) and around August 10 (75 flies per trap). Population peaks were associated with heavy rainfalls. The highest number of eggs per plant was observed in Lorsban 4E treatments (avg.= 5), and the lowest in "Garlic Barrier" drench treatment (avg.= 3). This demonstrated the relatively good repellent properties of "Garlic Barrier". The lowest damage to cabbage heads was observed with Lorsban 4E, which treatment which suggested good control of the larvae by the chemical after they hatched. Work on this project will continue in 1999/2000. This project was funded by Alberta Market Gardeners Association, Alberta Horticultural Congress, Garlic Barrier Organic Farm, Koppert Canada, Sturgeon Fertilizers Ltd., and the Alberta Agriculture Research Institute.

Evaluation of Orthene^{R} and entomopathogenic nematodes against woolly elm aphids and its effect on fruit yield in saskatoons

This was a joint project with Dr. K. Fry, Alberta Research Council, Vegreville. It included the insecticide Orthene and entomopathogenic nematodes, *Heterorhabditis megidis* as part of an IPM system. The project was partially funded by the Alberta Professional Horticultural Growers Congress Foundation. A one acre saskatoon test field was situated at the CDCN. This is long term projects and first results are expected in 1999 growing season.

Insect survey in mature saskatoon orchard, CDCN

A second year of insect surveys were carried out in a mature saskatoon orchard at CDCN. Yellow sticky traps and pan traps were used to monitor and collect insects. Yellow sticky traps were changed daily during the growing season (May-September) and pan traps twice a week. Samples collected during the growing season are being analyzed. The survey will continue in 1999. This will give a good map of insects inhabiting saskatoon orchards and time of the season in which they occur. This work is done in co-operation with Dr. K. Fry, Alberta Research Centre, Vegreville.

Insect survey in bedding plant greenhouses

Several bedding plant greenhouses in the Edmonton area were chosen for an insect survey. Fungus gnats were the primary insects in all surveyed locations, followed by shore flies, western flower thrips and greenhouse white flies.

Insect survey of greenhouse tomatoes

A survey was performed in a private greenhouse from February 8 until September 20, 1998. Insects were monitored with yellow sticky traps changed on weekly basis. The major concern was western flower thrips. Weekly applications of Garlic Barrier provided some reduction of thrips populations compared to biologicals which suggests that the use of garlic spray in combination with biological control agents may provide adequate insect control in greenhouse tomatoes.

Potato microtubers in seed potato production in Alberta

Project was funded by the Potato Growers of Alberta and matched by AARI and was done in co-operation with seed potato program at CDCN. Refer to the seed potato section of this annual report for details.

Technology Transfer Services

Many aspects of insect pest management and control were discussed with vegetable, fruit and greenhouse growers. The concept of IPM was high on the agenda among all of these groups. Extension work was carried out through commodity newsletters, Greenhouse Coverings (14 articles) and Prairie Fruit Grower (4 articles), phone calls, on-site visits, seminars, lectures and workshops.

The focus of the micropropagation program was placed on education and technology transfer to growers with tissue culture laboratories, as well as to growers who were interested in establishing the new laboratories. A tissue culture course was organized by the CDCN staff (February 1998). Consultations, diagnostics, and problem solving to growers were maintained via phone calls and office visits. Growing media compositions and techniques of disease freeing were presented to growers.

Fruit Crops Program

L.G. Hausher and S. Dalpé

The fruit crops program serves the developing and expanding berry and bush fruit industry in Alberta through applied research, development and technology transfer activities. Strawberries, raspberries, saskatoons and black currants are the primary crops studied, although other fruit crops are evaluated for their commercial potential. Extension and development activities are directed to producers and producer organizations, including the Alberta Market Gardeners Association (AMGA) and Fruit Growers Society of Alberta (FGSA).

Research Projects

Details on cultivar evaluation and cultural trials are the reported in CDCS Pamphlet *Fruit Crop Trials 99-6*. This report also includes results of fruit crop trials conducted at the CDCN, Edmonton.

Strawberries

Junebearing strawberry timing of winter mulch removal

Approximately 15 cm of wheat straw mulch was applied over replicated treatment rows of Kent and Glooscap strawberry plants on November 10, 1997. The straw mulch was removed at one-week intervals, commencing March 31 to April 28, 1998. Plants were harvested twice a week from June 25 to July 30. No significant yield differences were observed between removal dates with either cultivar evaluated.

Junebearing strawberry cultivar evaluation - second year production

Four Junebearing cultivars, Kent, Glooscap, Cavendish and Honeoye, were established and deblossomed in 1996. Harvests were made and reported in 1997. Rows were overwintered with 15 cm of wheat straw. This replicated trial was conducted at both CDCS and CDCN. Plants were harvested twice a week from June 25 to July 23 at Brooks and June 23 to July 24, 1998 at Edmonton. Although the cultivar Glooscap was the top producer at the Brooks site, it only significantly outproduced Honeoye. The cultivars Kent, Glooscap and Cavendish significantly out produced Honeoye at the Edmonton site.

Nova Scotia Junebearing strawberry selection evaluation - second year production

Seven strawberry cultivars and two advanced selections from Agriculture Canada, Kentville, NS were established in 1996 in a replicated trial, harvested and reported on in 1997, and overwintered with straw mulch. Harvests were carried out twice a week from June 25 to July 27, 1998. The standard cultivar Glooscap outproduced all cultivars and selections, with the exception of the standard cultivar Kent.

Quebec Junebearing strawberry cultivar and selection observation - second year production

Three strawberry cultivars and five advanced selections from Agriculture Canada, St. Jean-sur-Richelieu, Quebec were established in 1996 in an observational trial. One to ten plants of each were established, harvested and reported on in 1997, and overwintered with straw mulch. Harvests were carried out twice a week from June 25 to July 30, 1998. One of the advanced selections out yielded the standard cultivar Glooscap. The Quebec cultivars Oka and Chambly and four selections out yielded the standard cultivar Kent.

Junebearing cultivar evaluation - first year production

A replicated trial was established and deblossomed in 1997. Plants were overwintered with approximately 15 cm wheat straw mulch. Sixteen cultivars, many of which have not previously been evaluated, were obtained from the primary Alberta strawberry industry plant supplier. Additionally, four standard cultivars were also obtained from an additional source for comparison. The trial was repeated at CDCN, Edmonton as a single-row evaluation. Plants were harvested twice a week from June 18 to July 27 at Brooks and June 30 to July 24 at Edmonton. The standard cultivars Kent, Glooscap, Honeoye and Cavendish were the top yielders at both sites. No significant differences were observed between plant sources.

Day-neutral strawberry cultivar evaluation - second year production

Three day-neutral cultivars, Fern, Tristar and Seascape were established in a replicated trial at CDCN in 1997. Harvests were carried out in 1997 and the rows overwintered with wheat straw mulch. Harvests were made twice a week from June 16 to September 29, 1998. The cultivar Tristar had a significantly higher total yield than the other cultivars. The cultivar Seascape produced the highest percentage of marketable fruit.

Tristar day-neutral strawberry crown size evaluation

A replicated trial was established to evaluate production differences between Tristar plants with crown sizes at 1.5 cm and 4 cm. Plants were harvested twice a week from June 15 to October 8. Although not significantly different, the large crowns produced slightly higher yields than small crowns. The large crowns established runners earlier than the small crowns.

Day-neutral strawberry foliar feed evaluation

A replicated trial was established to evaluate the effect of weekly applications of nutrient (20-20-20) applied foliarly. Granular application of nutrients was done at similar rates to both foliar treatment and non-treatment rows of the three standard cultivars Seascape, Fern and Tristar. Plants were harvested twice a week from June 15 to October 8. No significant differences in production were obtained between cultivars or treatments.

Raspberries

Raspberry cultivar evaluation

A replicated trial was established in 1996 at Brooks and a single-row observational trial at Edmonton to evaluate the growth, yield, and fruit quality of nine floricane and two primocane raspberry cultivars. The majority of the cultivars have not been evaluated previously under Alberta conditions. Three cultivars fruited for the first time at Brooks and nine at the Edmonton site. Yields were low due to the age of the plantings.

Primocane raspberry cultivar enhancement - second year production

Five cultivars of fallbearing raspberries, Summit, Autumn Bliss, Ruby, Red Wing and Heritage, were established in 1990 as part of the North American Primocane Raspberry Genotype by Environment (G x E) Study. The study was completed in 1993. During the early spring of subsequent years, canes were mowed to the ground. One-half of each row was covered with a thin (Kimberly Farms 20 g/m^2) fibre row cover in April and removed when growth reached approximately 30 cm.

In 1998, one half of each row was not mowed and previous year's growth allowed to fruit. The half row that was mowed was covered with row cover as done in previous years. Plants were harvested twice a week from July 7 to October 5. There were no significant differences in yield between cultivars of either treatment. Ruby was the only cultivar that produced a significantly higher yield form the mowed/covered treatment than the second year production treatment. There were no significant production differences between treatments of the remaining four cultivars.

Primocane raspberry new cultivar enhancement

Three cultivars Red River, Double Delight, Fallbrook and one selection, 8001, were evaluated similar to the previous trial. There were no significant yield differences between cultivars or treatments.

Chokecherry/pincherry cultivar evaluation

Six chokecherry and five pincherry cultivars and selections were established in 1993/94 in an observational trial. All rows bloomed in 1998 with exception of Paul and BC chokecherries. The chokecherry cultivar Garrington produced an average of 9.7 kg/shrub and the pincherry selection Lee #3 produced an average of 9.2 kg of fruit per shrub.

Black currant/gooseberry cultivar evaluation

A number of new and older cultivars of both black currants and gooseberries were established in 1995, 1996 and 1997. Ben Lomond was the top producing black currant with an average 2.1 kg fruit/bush. Abundance was the top producing gooseberry with an average 2.3 kg fruit per bush.

Evans sour cherry observation

Plants of Evans sour cherry were established in 1988-89 in a well sheltered location. Shrubs first produced fruit in 1995, and very little fruit was obtained in 1996-97. A good flower and fruit set in 1998 resulted in an average yield of 5.9 kg fruit per shrub.

Saskatoon orchard regeneration trial

A trial was initiated in April of 1997 to regenerate a saskatoon orchard that was established in 1970. The orchard of original Smoky seedlings were cut with a rotary mower to a height of approximately 20 cm. Growth after one season (1977) averaged 120 cm. Growth recorded during the fall of 1998, after two growing seasons, averaged 180 cm. Although some flowering took place during the spring of 1998, fruit production was minimal.

In a related trial, ten cultivars of saskatoons were mowed to a height of 20 cm during March of 1998. After one growing season, the regrowth ranged from 125 cm for Thiessen to 70 cm for Moonlake.

Mongolian cherry orchard regeneration

A regeneration trial was conducted on an old Mongolian cherry selection orchard during the late winter/early spring of 1998. One-half the orchard was cut to ground level with pneumatic pruners. The other half of the orchard was cut to a height of approximately 20 cm with a rotary mower. There were no observable differences in regrowth or health between treatments by autumn. Regrowth measured 100 cm after one growing season.

Technology Transfer Services

Fruit Facts, a newsletter providing berry producers with up-to-date production and marketing information, was published monthly. Articles were prepared regularly for the Alberta Market Gardeners Association (AMGA) and the Fruit Growers Society of Alberta newsletters. A commercial berry production school and strawberry/raspberry fertility workshop were conducted in Edmonton. A saskatoon workshop was also presented in Edmonton. Assistance was given to the AMGA in the bulk ordering of strawberry plants for Alberta producers.

The program leader continued as secretary of the Alberta Professional Horticultural Growers Congress and Foundation Society; the Alberta Horticultural Congress Foundation; The Horticultural Congress Planning Committee; The Alberta Society for Professional Horticultural Advancement; and the AMGA.

Presentations were made to research, commodity, and advisory groups during the year. Assistance was provided in the planning and execution of the Alberta Horticultural Congress.

A Fruit Crops Research Trial Openhouse was held at CDCS.

Financial assistance from the AMGA made it possible to attend the North American Strawberry Growers Association, and the National Farmers Direct Marketing Annual Meetings.

The program leader responded to individual and commodity group requests for information and presentations.

A fruit crop program review was held to review research programming with industry.

Greenhouse Crops Program (Brooks)

J. Calpas, P. Coté and S. Graham

The greenhouse crops program serves southern Alberta's diverse greenhouse vegetable and floriculture industry by providing extension service and conducting greenhouse research. Significant changes were made in the focus and direction of the greenhouse program in 1998. Historically, extension accounted for 80% of program activities. This component has decreased as research now accounts for 70% of program activities and resources.

The scope of research activities has also expanded, not only through increasing the volume of applied research projects, but by the initiation of a basic research component of the program. Applied research i.e., research into new crops, technology and crop production techniques, remains as the main focus of the program; however, basic research now makes up 30% of research activities. For example, research is currently being conducted on the development of a biological control for the gray mold pathogen, *Botrytis cinerea* in greenhouse crops. The direction of the basic research program is towards reducing the environmental impact of greenhouse crop production.

This shift within the greenhouse crops program has coincided with a period of significant growth in the greenhouse industry in southern Alberta. Approximately 20,000 m^2 (5 acres) of vegetable greenhouses were constructed in 1998, maintaining the rate of expansion in the industry at about 10% annually for the last two years. As the industry expands, there is growing demand for specialized, increasingly technical, production information specific to southern Alberta's unique growing environment.

Education Leave

The Greenhouse Crops Specialist enrolled in a Ph.D. program at the University of Alberta and completed a four-month education leave from January to April. This leave allowed the Specialist to develop new skills which have been applied in the ongoing research of the greenhouse crops program. This graduate program is anticipated to take another three years before completion. Most of the work will be carried out at CDCS as part of the program's regular research and extension activities.

Research Projects

Vegetable Crops

The Greenhouse Crops Program at CDCS grows its vegetable crops pesticide-free. 1998 represents the third consecutive year for pesticide-free status.

Efficacy of precision placement carbon dioxide enrichment in Alberta greenhouse sweet pepper production

Carbon dioxide (CO_2) is one of the major raw products in the photosynthetic process, and the supplementation of CO_2 is one of the main reasons that significant yield increases have occurred in greenhouse production over the past five years. The normal ambient level of CO_2 in the atmosphere is approximately 320-350 ppm. CO_2 supplementation in the greenhouse generally aims to increase the level to 800-1000 ppm. Without CO_2 enrichment, the level of CO_2 in greenhouses can drop below ambient levels, which results in reduced crop performance and yield.

Carbon dioxide supplementation in Alberta greenhouses is primarily accomplished through the combustion of natural gas in CO_2 generators located throughout the greenhouse. Usually, one generator is used for every 1858 m^2 (20,000 ft^2). In addition to the production of CO_2, these generators can also give off ethylene, oxides of nitrogen, sulfur dioxide, ozone, carbon monoxide and hydrogen sulfide if the flame is not burning cleanly. Not only can these gases have a deleterious effect on the plants, they can also threaten the safety of workers. Liquid CO_2 is a clean source of supplementation and is used in some greenhouses during some times of the year; however, it is more expensive than the CO_2 generated from natural gas combustion.

The beneficial effect of high CO_2 levels is especially apparent under high light intensities as the rate of photosynthesis increases with increasing light levels. However, high light intensities are also associated with a requirement for higher rates of air exchange for cooling, which can result in a large loss of CO_2 from the greenhouse. Natural gas CO_2 generators also give off heat, which is another negative effect, especially in summer when adequate cooling can be difficult.

Alberta receives high light levels during the year and this is one strong advantage for greenhouse growers in the province. Associated with the high incident light are high ventilation rates i.e., upwards of one complete air exchange per minute during mid-summer.

There is an opportunity for significantly increasing the production in Alberta greenhouses through efficient CO_2 supplementation to the crop. Precision placement CO_2 supplementation shows promise as such a system. The primary advantage that a precision placement system offers is improved distribution of CO_2 within the crop.

Three commercial greenhouse sweet pepper cultivars were grown in 120 m^2 (1260 ft^2) greenhouses under both the "industry standard" control CO_2 supplementation regime, and the "precision placement" liquid CO_2 supplementation regime. Carbon dioxide levels were held at ambient (approximately 320 ppm) or less in the control greenhouse to reflect the CO_2 regime in commercial greenhouses. Carbon dioxide levels in the precision placement liquid CO_2 supplemented greenhouse were maintained at approximately 800 ppm. Carbon dioxide supplementation was carried out only during daylight hours i.e., 6:00 am to 9:00 pm on a typical summer day. Supplementation in the precision placement greenhouse was continuous during this period, regardless of ventilation rates, and allowed for the determination of a baseline for continuous CO_2 supplementation in greenhouse sweet peppers in southern Alberta.

Table 1. Yield of pepper cultivars (March 30 through October 5, 1998) under standard and precision placement CO_2 supplementation.

Cultivar	Precision Placement Liquid CO_2 Yield (kg/m^2)	Standard CO_2 due to Liquid CO_2 Supplementation Yield (kg/m^2)	Yield Increase (kg/m^2)
Robusto (red) De Ruiter Seeds	18.56	18.56	0
Fiesta (yellow) Enza Zaden	19.43	17.89	1.54
Eagle (orange) Enza Zaden	15.07	12.46	2.61

The average increase in yield due to precision CO_2 placement was approximately 1.38 kg, or 8%, resulting in an increased revenue of $6.50/$m^2$ or $0.61/$ft^2$. This is based on a price of $23.55/5 kg ($4.71/kg), average price to grower, all colors, all grades (small, medium and large). The cost of production for this increased yield, based on the cost of liquid CO_2 at $0.216/kg, was $28.93/$m^2$ or $2.69/$ft^2$. The cost of CO_2 was 4.5 times the increased revenue from CO_2 use.

Using an average price of $4.71/kg to the grower, it would take an additional 4.76 kg/m^2 in yield to pay for

the CO_2 used in the trial. This would require that a final yield of approximately 23 kg/m^2 be attained for the crop in order to break even, based on our yield figures. A good current commercial pepper yield standard for southern Alberta is 21 kg/m^2. To break even at the rate of CO_2 use demonstrated in the first year of this trial, a grower would have to increase production by approximately 26%, based on our yields. Carbon dioxide supplementation was maintained even under conditions of maximum ventilation, and it is very clear that it is not economical to use liquid CO_2 in this manner. In order to increase the cost effectiveness, improvements in managing the efficiency of CO_2 supplementation will be implemented. It should be possible to maintain the 10% yield advantage and decrease the amount of CO_2 introduced into the greenhouse.

These figures establish the baseline for the cost/return of continual liquid CO_2 supplementation at approximately 800 ppm in the canopy of a greenhouse sweet pepper crop grown under southern Alberta conditions. This is the first report of a baseline for continuous liquid CO_2 supplementation in a greenhouse vegetable crop in Alberta. By the end of the 1998-99 crop year improvements should refine the system to optimize CO_2 use to arrive at a cost/return profile reflecting efficient CO_2 use in a commercial greenhouse pepper operation.

Funding for this project was provided by Air Liquide Canada, the Red Hat Co-op, Applied Bionomics, Westgro Horticultural Supplies Inc., De Ruiter Seed, and the Alberta Agricultural Research Institute.

Long shelf life cluster tomatoes as an opportunity for crop diversification in Alberta greenhouses

Cluster tomatoes represent the next large scale opportunity for crop diversification for Alberta greenhouse vegetable production. In the last three years cluster tomatoes have captured 50% of Europe's greenhouse tomato market. It is estimated that the demand for cluster tomatoes in Alberta would support a 30% increase in tomato production in the province. There is currently no commercial scale cluster tomato production in Alberta.

A cluster tomato is one which, instead of being picked as an individual tomato, is harvested as the entire group or cluster of 4-6 tomatoes still attached to the truss or stem piece. A long shelf life (LSL) cluster tomato will remain firm up to three weeks after it has completely ripened. The current industry standard, greenhouse beefsteak tomato varieties, often begin to soften within the first week after being picked. These cultivars are often picked at mature green or slight red color stage in order to minimize handling damage while the tomatoes are moved through the wholesalers and into the stores. The advantage of LSL tomatoes is that they can be picked ripe and remain firm for about a week at home.

Not all cluster tomatoes are LSL cultivars; a number have the cluster tomato designation because of their smaller size and because they can be harvested as a cluster. The clusters are harvested at a stage when only the first fruit on the cluster is fairly ripe and the rest are pink in order to minimize handling injury and tomatoes going to market too soft. The consumer prefers clusters in which all the tomatoes are red over those that contain green or soft tomatoes. LSL cultivars have the advantage that they can be harvested when all of the tomatoes on the cluster are ripe or near ripe.

LSL tomato cultivars do not yet have the fruit size to break into the beefsteak tomato market, but breeding programs are looking for cultivars that will meet the size standards. A beefsteak tomato will come in at 200-280 g where current LSL tomatoes will come in at about 100-150 g. The market currently demands a larger cluster tomato, i.e. of 115 g minimum. In addition, clusters are made up of 4-6 tomatoes with a weight per cluster of 454-680 g (1-1.5 lbs). Clusters are harvested when all tomatoes have a touch of color.

This project evaluated the production potential of LSL cluster tomatoes under commercial greenhouse conditions over one full production year. The trial was conducted in a 130 m^2 (1,400 ft^2) research greenhouse with the plants grown at a commercial spacing and density. The environment, fertilizer feed and watering were regulated using a commercial environmental control system. This planting was managed in the same way as a commercial crop. The greenhouse facilities at CDCS are able to reach commercial yield

levels and closely approximate commercial greenhouses. The trial focused on two promising LSL cluster tomato cultivars, Dynamo and Impala (Sunseeds). Two repetitions of 15 plants per repetition were compared to two non-LSL cluster varieties Compari and Durasol (Enza) at two repetitions of 15 plants per repetition. Compari and Durasol served as controls. The repetitions were arranged in a complete by randomized design. Two beefsteak tomato cultivars Grace and Blitz (De Ruiter) were also included for comparing yield between cluster and beefsteak cultivars.

Twice during the season, two clusters from each cultivar were harvested and placed on a counter for shelf life determinations, where the number of days to softness was recorded. The indicator used to determine when a tomato/cluster became soft was the number of days to when a finger pressed against the side of the first tomato on the cluster left a permanent indentation.

Table 2. Mean yield of cluster and beefsteak tomatoes by type. Harvest period Mar 15-Oct 28.

Type	Yield (kg/m^2) Average of all Cultivars
Beefsteak	38
LSL Cluster	32
"Standard" Cluster	32

Table 3. Mean shelf life of the cluster and beefsteak tomato cultivars. Individual tomatoes were picked at the pink stage.

Type	Shelf Life (days)
Beefsteak	12.8
LSL Cluster	24.5
"Standard" Cluster	11.7

On average, both the LSL and standard cluster cultivars yielded the same. The cluster cultivars yielded approximately 16% less than the beefsteak cultivars. The average price for beefsteak tomatoes was $0.91/lb ($2.00/kg) and the clusters averaged $1.39/lb ($3.06/kg). Cluster tomatoes paid approximately 53% more per unit weight than beefsteak tomatoes. Factoring in the lower yield, when compared to beefsteak tomatoes, the return to grower was 29% higher for cluster tomatoes on a square foot or square metre basis. Cluster tomatoes returned approximately $9.30/ft^2 ($100/m^2), while beefsteak tomatoes returned approximately $7.27/ft^2 (78.26/m^2). The LSL cluster tomatoes also showed an increased shelf life of almost twice the "standard" cluster and beefsteak cultivars included in this trial.

Funding for this project was provided by Sunseeds, Applied Bionomics, Westgro Horticultural Supplies Inc., De Ruiter Seed, and the Alberta Agricultural Research Institute.

Culinary herb production trial

Culinary herbs represent a relatively untapped market opportunity for Alberta greenhouse growers. Some have experimented at growing culinary herbs, primarily basil, for the local fresh market with the majority of the product being moved through Farmer's Markets. There is a niche market opportunity for growing fresh culinary herbs for Alberta's food service industry wholesalers. Currently, this segment of the market in Alberta is held by British Columbia growers.

Fourteen different culinary herb types, with an emphasis on basil, were grown in a preliminary trial to assess quality and market acceptance. The objective of this trial was to identify three of the most promising candidates for further evaluation in a larger scale production trial to establish a cost/return profile.

Two week old transplants were placed into the production greenhouse on May 20. The plants were grown in sawdust bags, three plants per bag, at 15 cm (6 in) spacings. Each plant was supplied with its own drip tube and watering spigot. The plants were on a continuous feed with fertilizer being delivered at every watering. The plants were fertilized with 20-20-20 and calcium nitrate at 200 ppm of nitrogen. Harvest commenced on June 11 and continued with the same plants, until December 4. The product was evaluated in July by some of Alberta's top chefs, within the CP Hotel system.

Table 4. Yield and evaluation of fresh cut culinary herbs for the food service industry.

Herb	Yield (g/3 plants)	Comments
Winter savory	299	Suitable for Christmas market only
Sweet marjoram	543	Marketable herb, not as popular as basil
Lemon balm	2092	Would be a saleable winter crop
Fino basil	2624	Leaves too small
Thai basil	1792	Not outstanding
Spice basil	3910	Very impressive, strong clear scent and distinctive flavor
Sheep sorrel	2656	Bitter herb, not desirable
Anise basil	5093	Not a desirable flavour
Cinnamon basil	3539	Not impressive
Lime basil	2607	Very high impact. Good flavor and scent for cooking and garnishes
Lemon basil	3234	Good, but lime basil considered better
Sacred purple basil	868	Not impressive
Rubin basil	1973	Deep purple leaves have potential as a garnish
Genovese basil	8037	Good all-purpose variety with large succulent leaves, probably the most saleable.

Genovese basil was the best producer and was also very well received by the chefs. This is consistent to what was expected, as the growers who experimented with growing basil almost exclusively grew Genovese basil. Genovese basil has large leaves, which are preferred by chefs and the food service industry. Lime basil shows very good potential with regards to market acceptance; however it yields considerably less than Genovese basil. Spice basil also had a strong impact on the chefs and it yields better than lime basil, but still behind Genovese.

Based on these results, a larger-scale trial involving Genovese, lime and spice basil is scheduled for the 1999 crop year.

Preliminary investigation into Chinese leafy vegetables as a crop diversification opportunity for greenhouse growers

Greenhouse lettuce is an established crop in Alberta with approximately 2 acres of production. Butterhead lettuce has historically been the choice for greenhouse production. However, with the increasing consumer interest in leaf and specialty lettuce, more leaf lettuce, green and red, are being grown in the greenhouse.

There is also increasing consumer demand for Chinese vegetables in Alberta. Leafy vegetables such as bok choi, Chinese spinach, Chinese kale and mustard greens represent possible diversification opportunities for Alberta greenhouse lettuce growers. A number of cultivars of bok choi, Chinese spinach, Chinese kale and mustard greens were obtained from the Known-You Seed Company in Taiwan. The plants were grown

according to a commercial lettuce schedule. The plants were seeded into rockwool plugs and grown on the seedling table for 12 days. They were then transplanted onto a floating raft system, fixed plant spacings at (19 cm) 7.5 in. for an additional 5-5.5 weeks (summer schedule). The plants were floated using styrofoam sheets on a pond depth of 8 cm (3 in). The pond was filled with a standard lettuce feed.

The crop was assessed by wholesale vegetable buyers for quality and market acceptance. Quality was judged to be excellent for all the crops. The dwarf or baby bok choi cultivars were particularly well received as these compact types are in very high demand. The weight of each plant at harvest ranged from 170-250 g.

Based on the results of this trial, a large scale trial is scheduled for the 1999 crop year to develop a cost and return profile for these Chinese vegetables. North American seed sources are been located in order to facilitate more direct access to seed.

Investigation into green beans as a potential new greenhouse crop for Alberta

Industry interest in the potential of green beans as a greenhouse crop prompted a small trial at CDCS. Seeds of the cultivar Flavour (Rijk Zwaan) were seeded directly into conditioned sawdust bags for a final plant density of 8 plants per 20 litre bag or 5.4 plants/m^2. Two crops per year were anticipated, following a December seeding and a July seeding.

Germination to harvest took approximately 51 days. Preliminary yields established yield targets at 1.75 kg (4 lbs) per plant, based on 8 g pods. The quality of the product was excellent, well beyond any product that came from the field. Price ranged from $3.52 to $6.60/kg ($1.60 to $3.00/lb). Labor cost estimates were in the range of $0.52/kg ($0.24/lb) to pick, with at least another $0.52/kg cost in plant handling, pruning etc. Changes in feed programs and crop management over the course of the season resulted in improving the balance of the plants towards a more generative crop. If the crop is too vegetative, labour costs would make it uneconomical.

Based on this preliminary study, green bean production shows potential as a greenhouse crop diversification opportunity for Alberta. The success of green beans will depend on improving crop management techniques to reduce the amount of labour involved in crop handling and an adequate price for product. An estimated minimum desirable price for product would be $4.95/kg ($2.25/lb). The produce would have to be promoted aggressively based on its exceptional quality and it would have to be distinguished from field grown green beans.

As these results are preliminary, a large scale trial is still required in order to improve crop handling techniques and generate a more confident and complete cost and return profile.

Floriculture Crops

Greenhouse statice as a cut flower crop in Alberta

Work continued in 1998 on perennial *Limonium* (statice). It is a popular fresh cut flower and is also used for dried arrangements. This information is based on growing the Van Staaveren cultivars in the "Misty" series. The crop was grown in ground beds at a planting density of 4.8 plants/m^2. Transplants were placed into the beds in November and were allowed to establish in the beds for two weeks. The greenhouse temperature was then dropped to 8°C to overwinter the plants. Temperatures were raised to 20-21°C day, 13-14°C night in March to time the plants for first pick in April. The target was to have the crop in full production by Mother's Day in May. The picking period ran from April to November. Three to four years of production can be expected from a single crop.

The product was very well received by wholesalers and retailers. The plants were harvested once a week. Mature portions of the stems, (showing 80% open flowers) were harvested in 15-18 in lengths and

bunched in groups of five stems weighing from 190-200 g. Each bundle sold for $8-10 (grower price). The return to grower, based on the trial, would be $71.00/m^2 (6.68/ft^2).

This was the third year of the statice production trial. The crop remains a consistent performer and the product is in demand twelve months of the year. The major drawback for growers is the time that the area is out of production while the crop overwinters. It is important that statice overwinter in order to allow the plants to recover from the continuous production. Experience at CDCS with extending the production period was that the condition of the plants declined and production during the second year was lower. It should be possible to grow the plant as an annual crop, pulling the plants in November and using the space for another winter crop. However, a concern has been the availability and supply of transplants as the greenhouse program has had difficulty obtaining the plants for November transplanting. Plants in the Misty series are tissue cultured and not available from seed.

Basic Research Program

Development of a biological control for the gray mold pathogen, *Botrytis cinerea*, in greenhouse vegetable crops

Greenhouse crops are constantly threatened by the plant pathogenic fungus *Botrytis cinerea*, which causes gray mold or botrytis blight, as the fungus has a very wide host range. The wet, humid conditions that are common in the greenhouse environment favors the rapid development and spread of this disease. The biology of botrytis blight is well understood, yet this disease continues to cause significant losses in greenhouse crops. This is in spite of the fact that the disease can be one of the easiest to control through proper management of the environment. Strict control of the environment to prevent conditions which favours the development of botrytis blight is often very difficult, especially during the early months of the greenhouse cropping season in Alberta, January to March. Fungicides are commonly employed to control this disease; however, strains of the fungus are now resistant to a number of these products.

Development of a biological control for botrytis blight in greenhouses crops offers promise as an environmentally friendly alternative to fungicides. Biological controls are being sought for botrytis blight in a number of crops. Fungi in the genus *Trichoderma* are among the most promising biocontrol agents against plant pathogenic fungi, including *Botrytis*, and different strains have the ability to control a range of pathogens under a variety of environmental conditions. One specific strain of *Trichoderma harzianum* has been registered in Chile, Croatia, Greece, Hungary, Romania and Israel under the tradename Trichodex for the biological control of gray mold on grapes and strawberries. A similar product has been developed in the Shandong province of China for widespread use as a biological control for *Botrytis*. No such product is currently registered for use in Canada.

The best prospect for having a biological control for *Botrytis* registered in Canada lies in employing organisms which are native to Canada. This would simplify the registration procedure regarding the strict regulatory requirements that apply to any foreign organism imported into the country. The greenhouse industry in Canada generally has difficulty licensing pest control products due to the high cost of registration. This is especially true when a biological control product using a non-native control agent is concerned. Although the horticulture industry is expanding rapidly in Canada, it represents a small market when compared to the industry in other countries such as the U.S. and Holland.

The objective of this three-year project is to screen and develop native candidate microorganisms for use in the biological control of *Botrytis cinerea* in Alberta greenhouses crops. One hundred sixty isolates of *Botrytis cinerea* were collected from a variety of greenhouse vegetable and ornamental crops across Alberta. The isolates are being characterized based on their virulence against tomato. In addition, they are been differentiated based on their DNA. One hundred isolates of *Trichoderm sp.* have been collected from various sources throughout Alberta and are being established in pure culture. Work on the project is ongoing.

This project was funded by a direct funding grant from the Alberta Agriculture Research Institute.

International Exchange

Visiting scientist from China

Professor Han Jian Hui from the Vegetable and Flower Research Institute, Academy of Agricultural and Forestry Sciences, in Hebei province, China, spent the week of August 31 to September 4 working with the Greenhouse Specialist at CDCS. Professor Han was part of a larger Chinese delegation touring the agricultural industry in Alberta. He became familiar with the greenhouse research projects in progress at CDCS, as well as accompanying the Greenhouse Specialist on a number of extension calls to Alberta greenhouses. The experience resulted in a productive exchange of ideas regarding greenhouse research in China and Alberta.

Greenhouse Crops Program (Edmonton)

M. Mirza, M. Younus, W. Chen and M. Blank

Industry, Changes And Trends

The year was highlighted by the completion of an 8000 m^2 greenhouse facility in the Lacombe area. This greenhouse incorporated state-of-the art technologies, such as carbon dioxide recovery from the boiler stack, central inflation, natural venting and recirculation of waste water. Valuable experience was gained in the use of coco-peat (coir) to grow roses on a commercial basis using water biofiltration and recirculation technologies. Tree seedling production is expected to increase in 1999 due to demand created by forest fires for reforestation stock. The area devoted to bedding plant production continued to expand. The interest in evaluating new and inert growing media continued. Agricultural foam was tested by one grower for cucumber production and he found that roots formed a mat under the grow slab and water management was very critical. One tomato grower completed a third crop in Styrolite with good results and another grower is using this inert medium to grow tomatoes and cucumbers.

Research Projects

Evaluation of coco peat (coir) compared to sawdust for tomato production

Tomato cv. Blitz was seeded in early January and transplanted into 26 L sawdust pillow bags in the third week of February. Standard management practices were carried on throughout the cropping period. Harvest began in the fourth week of April and the crop was terminated during the second week of July. A second crop was seeded in the middle of June and transplanted into the same growing bags in the second week of August. Harvest began in the first week of October and the crop was removed in the third week of November. There were no significant ($P \leq 0.05$) differences in total weight or number of fruits per square meter between the two growing media. A second year trial will be conducted to compare the same treatments.

Evaluation of two irrigation systems for the production of seedless cucumbers

A pulsator-controlled minute drip irrigation system was compared with a normal drip irrigation system for cucumber production. The pulsator system delivers smaller amount of water per unit of time compared to the conventional system. The pulsator system allows for a horizontal spread of water and nutrient solution and less water is leached out. Cucumber cv. Harmonie was seeded in the third week of May and transplanted into 26 L sawdust bags in the third week of June. A pulsator-controlled and a conventional drip irrigation system were set up. Harvest began in the middle of July and the crop was terminated in the fourth week of August. Data were taken on marketable fruit yield(kg/sq m). There was no significant ($P \leq 0.05$) difference in total weight or number of fruit between the two systems.

Evaluation of different root media for poinsettia production

Four different rooting media were evaluated for the growth and development of two poinsettia cultivars in a commercial greenhouse. Rooted cuttings were transplanted in the first week of August in 15 cm pots with an approximate media volume of 1.3 L. The experiment was statistically replicated in a completely randomized block design. The media types evaluated were: a) peat and Styrolite or coco coir and Styrolite at a ratio of 3:1, b) peat, Styrolite and vermiculite at 2:1:1 ratio, and c) a commercial soilless mix. Regular pH, electrical conductivity (E.C.) and water use were monitored. Final visual observations of the crop were based on overall marketable quality. All media types were comparable to each other. The pH and E.C. values were within the recommended ranges throughout the cropping period.

Germination enhancement studies with *Echinacea angustifolia*

Work continued to find better methods of enhancing germination of echinacea. A protocol was developed and tested on different seed lots. The method involved surface sterilization of seed with 0.5% bleach, soaking in water for 24 hours at 22 °C under light, soaking in 400 ppm of etherl for 2 hours then germinating it at 22 °C. This method improved germination from a normal of 22% (no treatment) to up to 92% in some seed lots.

Greenhouse production of *Echinacea angustifolia*

Different seeding dates were compared in Styroblocks 112. Each block had 105 ml of growing medium in a cavity and held 112 plants in a 2 sq ft area. Nitrate and ammonium nitrogen were also compared for their effect on root biomass. Three seeding dates, i.e. middle of January, middle of March and middle of April, were compared. The roots were harvested in September and October. Significant ($P < 0.05$) differences in root biomass were seen between seeding dates. The highest root yield was obtained in January-seeded/September harvested plants. There were also significant differences in root biomass between nitrate and ammonium nitrogen treatments with biomass being greater in nitrate treatments.

A crop of echinacea was also seeded in the first week of January, planted in an aeroponic growing channel in the middle of February, and harvested in the third week of September. There were 35 plants/sq m. Average root dry weight was 16.4 grams/plant which translated into 573.0 g/sq m. Further experiments will be conducted at different densities.

Determination of echinacosides in *Echinacea angustifolia*

R. Currie and Y. Hoyano, Food Quality Branch, Edmonton

A rapid method for the determination of echinacosides was developed and several samples obtained from field and greenhouse were compared. Echinacosides determined on roots obtained from plants grown in Styroblcoks in a peat-based medium ranged between 1.08 and 1.45%. In case of roots fertilized with ammonium-based fertilizers, echinacisides ranged from 0.62 to 1.69%. Roots from aeroponically grown plants had an echinacoside content of between 0.65 and 0.85%. The highest echinacoside content (1.92%) was obtained in feeder roots of plants grown in peat-based medium with ammonium fertilizer applied. Samples obtained from field-grown echinacea showed an echinacoside content of from 0.22 to 1.48%.

Fatty acid contents of portulaca

D. Serbanescu and Rob Currie, Food Quality Branch

Purslane (*Portulaca oleracea sativa*) was seeded in the first week of March and transplanted in a commercial soilless mix in the third week of April at a density of 49 plants/sq m. The first harvest was at the end of May, followed by two more harvests in June and July. Plants were also fertilized with either ammonium or nitrate nitrogen. Omega- 3 and omega- 6 fatty acids were determined. Omega-6 fatty acids ranged between 16.6 and 29.9%, while Omega-3 ranged from 20.4 to 39.6%. Further studies are needed to develop this plant as a source of fatty acids for human consumption.

Technology Transfer Services

Greenhouse planning and production information was provided to over 250 people during the year. Greenhouse coverings, workshops and on site visits continued to be major technology transfer tools. Use of email for information transfer increased considerably during the year. Many growers with digital cameras send images through email for diagnostic purpose. Several articles in Agrinews were picked up by media which generated in information transfer.

Horticulture Development

B. Vladicka and S. Demers Collins

The objectives of this program area are to:

- facilitate the development of markets for Alberta horticultural produce as a commodity and as a value-added product.
- provide assistance to the industry to improve its competitive position.
- administer the Farmers' Market program across the province.

Funding was received from the Farm Business Management Program to produce a series of publications that will provide producers with some economic information on diversified operations. The project conducted by a team across AAFRD focussed on horticulture and alternative livestock businesses. Consensus Research Data (CRD) studies were conducted on u-pick strawberry, commercial saskatoon and calibre tree nursery operations.

This publication series builds on the work developed for the Ag Venture series of publications. In 1998, profiles on honey and u-pick berry operations were published. The saskatoon business profile produced in 1996 was revised.

Marketing activities focussed on the fruit and vegetable industry during the year. Consultations were held with wholesale produce buyers to improve the working relationships between staff and buyers, and to obtain more information on the needs of the buyers in the retail and food service sectors. This information was transferred to vegetable growers through one-on-one meetings and a series of workshops held across the province in December. The vegetable action team produced a crop report throughout the season for wholesale buyers.

Assistance was provided to the Fruit Growers Society of Alberta (FGSA) to help them formulate a marketing strategy for saskatoon berries. Changes in market conditions and philosophies of the FGSA delayed the completion of this activity. The work will continue into 1999. Activities are being formulated for both the fresh, directed marketed berries and the frozen fruit.

Assistance was also provided to the organic industry. The department's Organic Food Committee brought together the four certifying bodies within the province to discuss common issues and help bring about resolution to some of their problems. Much of the discussion during the year focussed on the development of national standards. B. Vladicka was also a member of the certification committees for OCIA Alberta #1 chapter and the Sustainable Agriculture Association.

In 1998, Alberta began the year with 111 recognized Farmers' Markets. Over the year, the number varied slightly as new markets were given "temporary status" and others folded for a period of time. Markets become inactive because of the lack of a market manager or the withdrawal of community support.

Results of the Farmers' Market in Alberta report were distributed and discussed at six workshops held across the province. The report was the culmination of a survey that was conducted the previous year which collected information from market managers, vendors and customers at three different times of the year. Consumers are patronizing the markets because of fresh, quality products and the social atmosphere. The majority of vendors are making a modest income at the markets. However, twelve per cent reported that the income generated at farmers' markets was their sole source of income with some reporting incomes in excess of $60,000.

Nursery Crops Program

C.L. Murray, N.G. Seymour (CDCS) and T.T. Pheh (CDCN)

The nursery crops program is focussed on research into cultural management practices for commercial nursery production and the evaluation of new plant cultivars. Extension activities are directed to growers and other members of the nursery-landscape trades industry and includes a close association with Landscape Alberta Nursery Trades Association (LANTA).

The Nursery Crops Program at the Crop Diversification Centre South (CDCS) in Brooks and Crop Diversification Centre North (CDCN) in Edmonton is managed by C. Murray as a single group. Program activities at CDCN are coordinated by technologist T. Pheh with assistance from L. Maryniak and C. Andrew, and at CDCS by technologist N. Seymour with assistance from A. Spencer, C. Safronovich and S. Lapp.

Woody Plant Evaluation Trials

Prairie regional trials (CDCS and CDCN)

The Prairie Regional Trials (PRT) were established in 1958 to evaluate the hardiness of woody plants on the Canadian Prairies. Dr. C. Davidson, Agriculture and Agri-Food Canada, Agri-Food Diversification Research Centre, Morden, Manitoba coordinates the trial and provides the plant material for the eight prairie sites. Plants are evaluated in the trials at CDCS and CDCN for five years. Each year height and width are measured and the plant material is visually rated for quality and winter survival. The collected data are sent to Morden where they are summarized and a report is produced approximately every three years.

The 1998 additions to the trial at CDCS were:
Juniperus horizontalis 'Blue Chip'
Juniperus horizontalis 'Emerson'
Juniperus horizontalis 'Green Acres'
Juniperus horizontalis 'Nebraska'
Juniperus horizontalis 'New Blue Tams'
Juniperus horizontalis 'Pulchellus'
Juniperus sabina 'Broadmoor'
Larix gmelini
Taxus x *media* 'Hicksii'
Thuja occidentalis #6402

The 1998 additions to the trial at CDCN were:
Juniperus horizontalis 'Blue Chip'
Juniperus horizontalis 'Emerson'
Juniperus horizontalis 'Nebraska'
Juniperus horizontalis 'Pulchellus'
Juniperus x *media* 'Pfitzeriana'
Larix gmelini
Taxus x *media* 'Hicksii'

Regional woody plant test program

Since 1983, Alberta Agriculture staff and the LANTA Growers Group and Research Committee have cooperated to develop and maintain The Regional Woody Plant Test Program (RWPTP). New tree and shrub introductions, generally from North America, are evaluated for five years at seven different sites representing different climatic regions in the province. Growth data are collected and plant material is visually rated yearly for winter survival and landscape quality.

Selected graduates of the RWPTP are featured in a garden centre plant promotion program called Garden Select.

Additions to the RWPTP at the seven test sites including CDCN and CDCS in 1998 were:
Cornus alba 'Bud's Yellow'
Cornus alba aurea
Daphe burkwoodii 'Carol Mackie'

Fraxinus x 'Northern Treasure'
Fraxinus pennsylvanica 'Foothills'
Hydrangea paniculata 'Tardiva'
Potentilla fruticosa 'Floppy Disc'
Potentilla fruticosa 'Red Robin'
Prunus padus 'Sunstar'
Viburnum lantana 'Mohican'

For more information about the RWPTP from 1983-1998 see *Regional Woody Plant Test Project, Summary Report - 1998, CDCS Pamphlet #99-26* or on the Internet at http://www.agric.gov.ab.ca/crops/trees/rwptp/index.html.

The University of British Columbia plant introduction program - CDCS

The University of British Columbia Botanic Garden Plant Introduction Program selects superior plant material from many sources to test for suitability for introduction into the nursery-landscape industry. *Lonicera* 'Son of Mandarin', from this program was planted in 1998 at CDCS.

All-America selections (CDCS)

All-America Selections is a non-profit organization dedicated to promoting the development and introduction of improved cultivars of flowers and vegetables. The CDCS location is one of the approximately 35 trial sites in North America. The results of the evaluations from all the sites are tabulated and the best selections are released 18 months later. In 1998, 10 flower selections were evaluated.

The best new bedding plants from the All-American Selections to be available in spring 1999 are: Tritoma 'Flamenco', Verbena 'Quartz Burgundy', Portulaca 'Sundial Peach', Marigold 'Bonanza Bolero', Begonia 'Pin Up® Flame', Osteospermum 'Passion Mix', Zinnia 'Profusion Cherry', Zinnia 'Profusion Orange'.

The performance of all bedding plants tested at CDCS is documented in the CDCS Pamphlet #99-2 Annual Flower Trials 1998.

Bur Oak Provenance trial (CDCN)

The Bur Oak Provenance Trial is a cooperative trial with the Great Plains Agricultural Council, Forestry Committee and coordinated in Canada by W.R. Schroeder, Prairie Farm Rehabilitation Administration (PFRA) Shelterbelt Centre, Indian Head, Saskatchewan. The objectives of the project are: 1) to determine the nature and extent of bur oak genetic variation; 2) to provide genetically improved bur oak seed for shelterbelt planting; 3) to provide germplasm that can be used for selection and trait improvement as well as advanced-generation breeding; and 4) to survey the distribution and impact on seed quality of *Curculio* spp. (acorn weevil).

The project began in 1993 and is expected to run for approximately 20 years. There are 48 accessions in the trial from the following locations: Manitoba (19), Saskatchewan (4), Minnesota (4), Montana (3), North Dakota (16), South Dakota (2).

Vineland Apple Rootstock Trial (CDCN)

The Vineland Apple Rootstock Trial is a cooperative trial coordinated by Dr. J. Cline, University of Guelph, Horticultural Experiment Station, Simcoe, Ontario. The trial will evaluate the cold hardiness of the "V" series of rootstocks. There are currently four standard selections for the control (Ottawa 3, M9, Beautiful Arcade, Columbia) and five new selections bred at the Simcoe Station. The trees were planted in 1997 and will be on trial for five years.

Research Projects

Investigation of the growth of two species of field-grown trees at different nitrogen fertilizer rates (CDCN and CDCS)

C.L. Murray and R.C. McKenzie

Field-grown plant material is the largest segment of the nursery industry in Alberta. Alberta growers reported $11.2 million in sales of deciduous and coniferous trees and shrubs in 1992 (Pacific Resource Consultants, 1993). There is inadequate information about the management of fertility for maximum tree growth in the short Alberta growing season while avoiding over fertilization which may result in winter kill or dieback of trees.

Picea pungens 'glauca' (Colorado blue spruce) seedlings and *Fraxinus pennsylvanica* 'Summit' (Edmonton) and 'Patmore' (Brooks) (green ash) were planted on an unirrigated site in Edmonton and an irrigated site near Brooks. Four replications of groups of two or three trees of each species received nitrogen (N) fertilizer to reach each one of four soil N levels: control (no added fertilizer), 50, 90 and 130 kg N/ha. In Brooks, the trees were planted June 11 1997, while in Edmonton, the ash were planted in early May 1997 and spruce early May 1996. Trees were fertilized each year based on soil nutrient analysis, in June in Brooks and using a split application of fertilizer, in mid-June and the first week of July, in Edmonton.

Trunk caliper at 15 cm above the soil level or above the graft union and tree height were measured at transplanting and again in October of both years. Leaf tissue was collected in mid-August 1998 in both locations and analysed for micronutrient content.

There were no significant differences in tree caliper increase (increase from May to late September) in both years or for tissue N content for ash or spruce in 1998 as a result of the N treatments applied. A significant increase in growth due to the application of the N treatments was not observed in the first growing season, likely as a result of transplant shock and N stored in the tissues from the previous growing season. Lack of growth response or measurable differences in tissue N content in the second season was not unexpected because of the generally slow response of trees to fertility treatments. This research will continue for a minimum of two more growing seasons.

The authors wish to thank the following organizations for the financial support of this project: Alberta Agriculture Research Institute, Arrowhead Nurseries, Edmonton and the Alberta Ornamental Plant Foundation.

Investigation of sawmill by-products as media components for container production in the nursery (CDCS)

Various forestry industry by-products such as bark chips and sawdust have been used in nursery production as media components. In container-plant production, media components are chosen to develop a medium that is cost efficient to make, easily available and with good physical characteristics such as adequate porosity and water holding capacity. Several grades of sawmill by-products have potential for use as media components in the nursery industry.

On May 6 and 7, 1998, plants of each of three species, *Potentilla fruticosa* 'Coronation Triumph' (Coronation Triumph potentilla), *Spiraea* x *bumalda* 'Goldflame' (Goldflame spiraea) and *Picea pungens* (Colorado spruce), were transplanted into #2 containers, containing one of the following 12 media treatments:

Treat No.	% Fines	% Chips	% Peat	% Sand
1	25	0	65	10
2	50	0	40	10
3	75	0	15	10
4	100	0	0	0
5	0	25	65	10
6	0	50	40	10
7	0	75	15	10
8	0	100	0	0
9	25	65	0	10
10	50	40	0	10
11	75	15	0	10
12 Control	25% Sawdust:65% Peat:10% Sand			

The sawmill by-products were in two grades: the chips were a coarse product up to 10 cm long and the fines were a smaller product with particles up to 4 cm long. To adequately irrigate the media water was applied based on measurements of water loss from evapotranspiration. All treatments were fertilized with Osmocote 60% 3-4 + 40% 8-9 month release at 8 g N/pot, dolomite and gypsum at 1.2 kg/m^3 and Micromax at 1 kg/m^3 incorporated at mixing.

Potentilla leaf tissue was collected mid-August, dried and sent to the Soil and Crop Diagnostic lab in Edmonton for analysis. In late September 1998, height and width of plants were measured and growth index was calculated. Also one plant per treatment level was harvested then the shoot was dried and weighed. The remaining plants were consolidated into a hoop house which was subsequently covered in a single layer of opaque poly for overwintering.

The potentilla were largest when grown in treatment 6 followed by treatment 1 while spiraea were largest in the control treatment followed by treatment 5. The spruce also were largest when grown in treatment 6 followed by treatments 2 and 5.

Tissue N content was lower treatments in 2, 3, 4, 9,10 and 11 than in other treatments. All of the these treatments had fines in them, which indicates a lower availability of N where fines were used. This may be a result of rapid microorganism breakdown of the smaller fines utilizing available nitrogen and leaving less available for plant uptake.

The authors thank Spray Lakes Sawmills for financial assistance with this project.

Evaluation of Prairie Mix controlled-release fertilizer for growing woody plants in Alberta (CDCS)

Preliminary results from the project, *Investigation of controlled-release fertilizer for container-grown woody plants in Alberta,* conducted at CDCS, indicated that the growth of potentilla, alpine currant and lilac was greater when fertilizers with a 100% or 60% 3-4 month release period Osmocote controlled-release fertilizer were used. Based on these preliminary results, Prairie Mix fertilizer (PMF), a custom-blended, controlled-release fertilizer, was created for use under Alberta climatic conditions. The 21-3-7 formulation was manufactured for a 5-6 month release period and has a combination of controlled-release 19-6-12 and Poly-S (a coated urea product)

Rooted cuttings of *Ribes alpinum* (alpine currant), *Cornus alba* (Tatarian dogwood) and *Potentilla fruticosa* 'Coronation Triumph' (Coronation Triumph potentilla) were planted into #2 containers filled with a soilless media. Plants of each species were fertilized with PMF at 4.8, 6.4 or 8.0 g N/pot or Osmocote 60% 3-4 + 40% 8-9 month 8.0 g N/pot for the control. Fertilizer was incorporated into the medium in 1997 and top-dressed in 1998.

In the first season the growth index was greater for plants grown with PMF at 8.0 g N/pot than with 4.8 g N/pot or the control. In 1998 there were no differences in growth index or dry weight among the treatments.

In 1997 the greatest growth occurred with the PMF at the 8.0 N rate indicating that the species benefited from the high N rate. However, in 1998 there were no differences in growth among the treatments, indicating high N rates were not necessary in the second season. The lack of response to the fertilizer treatments in the second season may have been a result of unused fertilizer from 1997 being released for plant use in 1998.

A comparison of the growth of native plants grown in containers at three nitrogen rates and in the field (CDCS)

Native plants can be valuable in the landscape, for site reclamation or for shelterbelts. They are often slow growing; however, if growth could be accelerated with improved crop management, native plants would be a more profitable crop.

Rooted cuttings of *Sheperdia canadensis* (Russet buffaloberry), *Rosa woodsii* (wild rose) and *Larix laricina* (larch) were transplanted into soilless media in #1 containers. Container-grown plants were fertilized at each of three levels of N (3.1, 4.8 or 6.5 g N/pot) and the field-grown control was fertilized at the high N rate. The height and width of each plant was measured in September 1997, plants were overwintered, grown on, then measured and harvested in September 1998.

For container-grown plants, in 1997, the growth index was not significantly different among the three N rates for any of the species. In 1998, larch growth index was larger when grown at the 4.8 and 6.5 than at the 3.1 N rate and there were no differences among treatments for rose and buffaloberry growth index. In 1998, the larch dry weight was largest at the 6.5 N rate and at the 6.5 and 4.8 N rate for rose.

In 1997, field-grown rose and buffaloberry were smaller than the container-grown plants, while in the second season growth of the field grown buffaloberry and rose were much larger than the container-grown plants, likely due to the constriction of growth in the #1 container. Container-grown larch were larger in both seasons than field-grown larch as a result of the higher level of management of fertility and irrigation in containers.

Evaluation of the effect of media, IBA concentration and timing on rooting efficiency for softwood cuttings of six species of woody plants (CDCN)

A number of species of shrubs are considered by growers to be difficult-to-root using softwood cuttings and this limits their availability in the marketplace and increases the cost of production of these species. Many factors including the properties of the media, the concentration of rooting hormone applied and the time when the cuttings are taken are known to effect the success of rooting.

Cuttings of new green shoots 7 to 10 cm long were collected from mature *Prunus fruticosa* (Mongolian cherry), *Prunus pennsylvanica* (pincherry), *Sheperdia argentea* (Silver buffaloberry), *Hippophae rhamnoides* (sea buckthorn), *Corylus cornuta* (Beaked hazelnut), and *Syringa* x *hyacinthiflora* 'Royal Purple' (Royal Purple lilac). Cuttings were collected on 26 May, 10 June and 24 July 1998 and were stuck in rooting medium in root trainer containers the same day. Each cutting received one of the two IBA (indole-3-butyric acid) powder concentrations (0.4%, 0.8%). Cuttings were evaluated for root development after five weeks.

Rooting for all species was less than 15% except sea buckthorn and Beaked hazelnut. The sea buckthorn rooted at 76.6% on 10 June, 62.5% on 26 May and 51.8% on 24 June, while the hazelnut rooted at 80.5% on 26 May and less than 35% on the other two dates. There were no differences in the amount of rooting with either of the IBA concentrations for any of the species.

Rooting of *Betula papyrifera* 'Chickadee' (Chickadee birch) was evaluated on cuttings taken and stuck into a rooting medium on 27 May, 3 June, 10 June, 17 June, 24 June and 8 July. Each cutting received one of the following treatments: IBA powder at 0.1, 0.4 or 0.8 % or IBA solution at 0.1, 0.2%. The tips of cuttings taken on these dates dried up. Extra cuttings had the top two nodes removed and only then was there any rooting.

This study will continue in subsequent seasons to evaluate various treatments to improve rooting of these species.

Evaluation of POLYON and Japanese controlled-release fertilizers for growing woody plants in containers (CDCS) C.L. Murray and R.C. McKenzie

Controlled-release fertilizers are commonly used in nursery production for efficiency. Many of these fertilizer products have been developed in other nursery growing regions around North America and the world. To be effective in Alberta, research needs to be conducted to evaluate the fertilizer release properties under our climatic conditions.

Two groups of products were evaluated in 1998. *Ribes alpinum* (Alpine currant) were grown in #2 containers at each of two N rates, 5 or 8 g N/pot and with four different products: POLYON incorporated 21-9-12, and POLYON topdress 22-9-10, Urea 40-day 46-0-0, Urea 70-day 46-0-0, Urea 100-day 46-0-0 with a sigmoid curve release pattern. All fertilizers were incorporated into the medium at mixing. -The control was Osmocote controlled-release fertilizer 60% 3-4 + 40% 8-9 month release at 8 g N/pot.

The currants were larger when grown with the Urea 70-day fertilizer at the 8 g N/pot than the POLYON incorporated at 8 g N, POLYON top-dressed at 8 g N and Urea 40-day at 5 and 8 g N. The smallest plants were grown with the Urea 100-day fertilizer at both N rates.

The authors wish to acknowledge Westgro Horticultural Supplies who provided POLYON products and Z. Minchu who provided the Japanese products.

Evaluation of Japanese controlled-release fertilizers for growing marigolds in the growth chamber (CDCS) C.L. Murray and R.C. McKenzie

Controlled-release fertilizers are being developed around the world for a variety of agricultural uses. New products from Japan were made available for evaluation for growing nursery crops in Alberta. To complement research conducted in the field, the fertilizers were also tested under growth chamber conditions.

On May 25 1998, *Tagetes* sp. (marigolds) seedlings were transplanted into #2 containers. Four fertilizer treatments were evaluated: Urea 70-day release, Urea 40-day release, Urea 100-day with a sigmoid curve release pattern and for the control, Osmocote 60% 3-4 + 40% 8-9 month. All fertilizers were applied at three N rates 5, 8, 12.8 g N/pot. Plants were grown in the growth chambers with 12 hours of light and 12 hours at 12 C, 6 hours at 21 C and 6 hours at 6 C. On Sept. 9 height and width were measured, plants were harvested and dried, then dry weights were measured.

The marigold dry weights were largest with Urea 70-day and the Osmocote treatments at the 5 N rate. The lowest N rate resulted in the largest marigold growth with each of the different fertilizer treatments except Urea 100-day. The plants were severely damaged or killed by excessive salt concentrations at the high N rate with all fertilizer treatments.

The Urea 70-day and Osmocote treatments were the most effective for plant growth under the growth chamber conditions. The Urea 100-day sigmoid release pattern was characterized by an initial lag time with very little N release then a rapid N release. Since the medium did not have any native nutrients to sustain early plant growth the Urea 100-day system released nutrients later than was necessary for rapid growth.

The authors thank Z. Minchu for supplying the fertilizer and L. Hingley for technical assistance.

Altering the medium pH of container-grown woody plants utilizing various sulphur products and rates (CDCS)

The medium used for container-growing woody plants is generally a soilless or low soil product, which is necessary to alleviate the poorly drained conditions in the container. Container media generally have a low buffering capacity, so the pH of the medium is highly influenced by the quality of the irrigation water. Previous research using irrigation water from the Bow River system saw a rise in pH in containers from an average of 6.8 to 8.0. Plant growth and quality are affected by high pH (above 7.5), which reduces the availability of phosphorus and micronutrients, especially iron and manganese.

Sulphur products can be used to reduce the pH of the container medium but little information exists on the rates required to reduce the pH or the affect on medium pH throughout the growing season.

Rooted cuttings of *Cornus alba* (Tatarian dogwood) were grown in #2 containers with three sulphur products: elemental sulphur (0-0-0-95), Tiger 70 (6-0-0-70) and Tiger 90 (0-0-0-90) incorporated into container medium at two rates 0.45 or 0.89 kg/m^3. Plants in the control treatment had no sulphur added to the medium.

Medium pH was measured once per month during the growing season and there were no significant differences in pH and no differences in plant growth with the different treatments.

These results were inconclusive so the experiment will be repeated in 1999.

Plant Collections CDCS and CDCN

The **Golden Prairie Arboretum** was established in 1981 at CDCS. The collection now contains 312 species of 68 genera for a total of 531 deciduous trees and shrubs. These plants represent most of the deciduous woody plant species that can be grown on the prairies. A complete listing of the collection is available in *Golden Prairie Arboretum* ASCHRC Pamphlet 93-1.

The **Forever Green Pinetum** collection of coniferous trees and shrubs at CDCS was established in 1986. At present it contains 26 species of nine genera for a total of 120 trees and shrubs. A complete listing of the collection is available in *Forever Green Pinetum* ASCHRC Pamphlet 93-12.

The **Rose Garden** contains 241 specimens, many of which are unique to the CDCS collection. Many early Canadian rose cultivars and notable crosses of Canadian rose breeders, Skinner, Bugnet and Wallace are maintained in the collection.

The **McCalla Arboretum** at CDCN currently being redesigned to reduce maintenance. To date 192 taxa have been planted in the redesigned Arboretum.

Technology Transfer Services

Technology transfer to the growers is accomplished through nursery visits as well as by the production and distribution of the Nursery Crops Trial Report and presentation of seminars. In 1998 the seminar 'Nursery Research Trials' was presented at the Alberta Horticultural Congress.

Participation in the LANTA Research Committee, Growers Group and the Western Nursery Growers Group allows for excellent communication with industry members. The program leader attended the LANTA Growers and Garden Centres Seminar, Nursery Efficiency, New Plants, Market Trends in February, 1998 and the Canadian Nursery Landscape Association Summer Tour in Calgary in August 1998.

Plant Pathology Program

P. Bains, H. Bennypaul, and M. Yu

The plant pathology program at the CDCN in Edmonton conducts research on disease of economic crops with the objective of reducing losses caused by various plant diseases. The program transfers information, generated from these research projects and collected from literature and scientific meetings to the respective industries. The program applied for and obtained research funds from Potato Development Inc. (Potato Growers of Alberta), Fruit Growers Society of Alberta, Novartis Crop Protection and Alberta Agricultural Research Institute.

Research Projects

Fusarium dry rot of potatoes: fungicidal control, soil survival, and effect of rotation crops on pathogen population

The research project is funded by Novartis Crop protection and AARI and is in cooperation with Drs. Larry Kawchuk, Agriculture and Agri-Food Canada, Lethbridge and Jim Holley, CDCS, Brooks.

Results of *in vitro* studies conducted to identify fungicides effective against thiabendazole (Mertect)-resistant isolate of *Fusarium sambucinum* showed that fludioxonil (Maxim) and imazalil (Fungaflor) were effective in inhibiting the growth of the pathogen. Maxim completely inhibited the growth at 2 ppm (the lowest concentration tested), whereas similar effect for Fungaflor was achieved at 50 ppm. Easout, Mertect, Tuberseal and lime were not effective. Novartis Crop Protection is using the data for registration of Maxim for controlling this disease.

A field experiment was planted to determine the efficacy of seven fungicides as seed treatment in controlling the development of the disease from dry rot-infected seed tubers. The seed tubers, before planting, were inoculated with a Mertect-resistant isolate of *F. sambucinum* and incubated for development of dry rot in an incubator. At harvest, soil samples were taken to determine the inoculum potential (ability to cause the disease) of the soil surrounding the daughter tubers. The inoculum potential determination experiments are in progress in the laboratory.

Another experiment was planted to examine the survival of the pathogen in the soil and determine the effect of plants of various crop species on pathogen population. Soil samples have been buried in the field for checking the survival of the pathogen, and this year's experimental plot site will be used for planting plants of various crops in 1999 crop year.

Fungicide efficacy, and crop rotation field experiments have been harvested. Soil samples surrounding the progeny potatoes were collected and will be used to determine the inoculum potential of the soils and in turn the effect of fungicide treatments on spread of the pathogen from infected seed tubers.

Entomosporium leaf and berry spot of saskatoon (Entomosporium mespili)

Partial funding for the project was provided by Fruit Growers Society of Alberta.

A replicated field experiment in four commercial saskatoon orchards was initiated to evaluate the efficacy of Bravo (chlorothalonil), a contact fungicide, for controlling entomosporium leaf and berry spot disease of saskatoon. Bravo at both rates (1.94 L or 2.4 L per hectare) reduced disease incidence and severity compared to that of water control. Berry samples have been collected for residue analysis. Pest Management Regulatory Agency, Health Canada, however recently indicated that an assessment of chlorothalonil is required - the potential concern is a microcontaminant. Until the assessment is complete no further new uses may be permitted on the label.

Late blight of potato

Cool and wet weather conditions in late June and early July were very favorable for the disease. The disease, however was not observed till the first week of August. Fifteen fields in southern Alberta were confirmed to have late blight infection. In spring, cull piles especially relating to infected fields, will be monitored for late blight infection and managed accordingly.

Stem canker and black scurf of potatoes (*Rhizoctonia solani*)

Clive Schaupmeyer, CDCS Brooks, is a cooperator on the project and this project. The project funded by Novartis Crop protection, Potato Development Inc. (Potato Growers of Alberta), and AARI.

Second year field trial to evaluate the efficacy of various fungicides, as seed treatment, for controlling the disease was conducted at Bon Accord, Alberta. The fungicides tested included difenoconazole @ 0.33% and 0.5% (Dividend), Fludioxonil @ 0.33% and 0.5% (Maxim), iprodione (Rovral), thiophanate-methyl (Easout), Maxim and Dividend combinations @ 0.33% and 0.5% each, thiabendazole (Mertect), captan (Captan) and calcium oxide (Lime). The results of various observations in 1997 and data of 1998 on stem canker severity on potato stems and black scurf severity on progeny tubers taken together suggest that both concentrations of fludioxonil (0.33% and 0.5%) as seed piece treatment provided effective control of stem canker and black scurf disease of potatoes.

Except lime, all treatments reduced incidence and severity of black scurf on daughter tubers. Both concentrations of Maxim and Mertect were significantly better in controlling the disease on tubers compared to the disease control provided by both concentrations of Dividend, Easout, and Captan. Easout, Captan, Rovral, and Tuberseal provided similar control of black scurf severity. A field experiment was also conducted to determine the comparative susceptibility of potato cultivars to *R. solani*. The results of 1997 and 1998 field experiments also indicated that potato cultivars differ in their susceptibility to the pathogen.

In general the results of 1998 field experiment were similar to the results obtained in 1997 field experiment. Based on these results, Novartis Crop Protection is pursuing registration of Maxim as seed treatment to control Rhizoctonia disease of potatoes.

Other

As a core member of AAFRD's Environmental Strategy Development Team, prepared an environmental strategy document, "A Proposed Framework for Leadership in Environmental Sustainability", for the Executive Committee. One of the key recommendation, creation of an Environmental Strategy Implementation Team, has already been acted upon.

Technology Transfer Services

Information on disease control was provided by farm visits, telephone, presentations, radio, and one to one discussions. In addition, the results of research projects were published in newsletters and as research reports and scientific papers. The program leader attended many industry and scientific meetings, workshops and courses including annual, areas and many breakfast meetings of Potato Growers of Alberta, annual meeting and berry school of Fruit Growers' Society of Alberta, Saskatoon berry Production Workshop organized by Saskatchewan Fruit Growers' association, course on Principles and Practices on Plant Tissue Culture, Alberta Horticulture Congress, International Congress of Plant Pathology, and joint meeting of Plant Pathology Society of Alberta and Canadian phytopathological Society, Saskatchewan Region.

Potato Agronomy Program

C. Schaupmeyer and C. Feth

The objectives of the potato agronomy program are: 1) to assist in the selection and development of improved potato cultivars and, 2) to establish methods for improving quality and maximizing economic yields in Alberta's potato industry. These objectives are accomplished through research, extension and service.

Research Projects

Potato cultivar improvement

CDCS is one of five cooperative tests sites in the Prairie Potato Breeding Program. The program is managed by the Agriculture Canada potato breeder, Dr. Dermot Lynch, who makes crosses at the Lethbridge Research Centre and does preliminary selections at the Vauxhall substation. Final testing is done at regional sites. Performance of test lines in the regional trials is evaluated by the breeder, test site cooperators and industry staff.

The primary objective of the breeding program is to select improved potato varieties adapted to the southern Prairies. Varieties needed by the industry include: a chipping variety that is more stable in long-term storage; an early chipping variety that will yield well and chip by the third week in July; an attractive fresh-market red potato that holds color in long-term storage; a maincrop fresh-market and French fry netted skin potato that is earlier than Russet Burbank and has better quality.

CDCS participates in cultivar evaluation in several ways. First, as a cooperator in the Prairie Regional Potato Trials, four cultivar evaluation trials containing about 400 lines are planted and managed. Second, some of the seed for the five regional trial sites in the Prairies is produced. Third, program staff participate with industry in the evaluation of advanced cultivars that have graduated from the regional trials.

Prairie potato regional trials

Approximately 400 lines were grown in five regional trials at Brooks. Data were collected on 30 to 40 agronomic and quality factors including yield, maturity, specific gravity, culinary and processing quality. Data from these trials were sent to Dr. Dermot Lynch at the Agriculture Canada Research Station in Lethbridge for analysis and summarization for the Prairie Potato Breeding and Selection Committee. Data from the regional trials are published in the annual report *Progress Report, Prairie Potato Regional Trials*, available from Agriculture Canada.

Alberta potato industry cultivar evaluation

Potato industry cultivar trials are continuing to evolve. The trials were originally established to evaluate new potato cultivars that have graduated from the Prairie Potato Regional Trials (on a commercial scale). The trials enabled growers and processors to gain first-hand experience with new cultivars in the field and processing plant. Six years ago, the Prairie Potato Breeding Consortium was established and responsibilities for industry evaluation are evolving. The consortium is a corporation funded by membership fees paid by five groups (processors, grower-owned companies, and grower organizations) from the three prairie provinces. Fees are used to pay for research studies directly related to consortium varieties.

Breeding lines entering the registration trials in the Prairie Potato Breeding Program are available for tendering to consortium members. The first tendering process started in late 1995. Successful bidders were assigned either exclusive rights or non-exclusive rights and were authorized to control the production of seed. They are required to pay a royalty to the consortium for the right of ownership. The owners of consortium varieties are responsible for market development of the varieties thus reducing the role of CDCS in this process. In 1998, CDCS increased seed of 26 consortium varieties for trials in 1999.

Potato cultural research

No agronomy management studies were conducted in 1998.

Technology Transfer Services

The program agronomist provided extension service to growers and industry personnel through direct contact, newsletters and fact sheets, and presentations at conferences and workshops. In 1993, the program agronomist started a series of extension meetings with growers in Southern Alberta. For the sixth consecutive year, these were continued in 1998 in cooperation with the Potato Growers of Alberta. Eight meetings were held in both Taber and Nisku from April through November. Growers, industry staff, and research and extension staff attended these meetings and discussed production management. Attendance at each meeting during the past year was from 100 to 120 growers and industry staff in Taber, and approximately 40 to 50 growers and industry staff in the Edmonton area. In total, approximately 900 growers and industry staff attended these informal extension/production meetings in 1998.

In 1998, two multi-national potato processing companies announced that new frozen French fry processing plants will be built in southern Alberta. Lamb-Weston, Inc. started construction of a $100 million plant east of Taber, Alberta. The plant will start processing in the spring of 1999 and, when at full capacity in 2000, will require 180,000 tonnes of raw potatoes.

In August 1998, McCain Foods (Canada) Ltd. announced construction of a similar plant that will be located between Taber and Lethbridge. When the plant is at full capacity in 2001 it will require 200,000 tonnes of raw potatoes. The two plants will require about 9,000 to 10,000 ha of potatoes.

These companies are locating in southern Alberta because of the high quality of processing potatoes grown here. In the past decade, potato producers have increased the productivity by improving seed quality, cutting and planting management, and fertility management. These improvements are a result (in part) of agronomy studies conducted in the CDCS potato program in the past decade, and a result of the aggressive extension activities by program staff. The expansion of Alberta's potato industry is a credit to many AAFRD and Potato Growers of Alberta staff, who have worked in many ways to attract new processors to Alberta.

Seed Potato Program

P. Duplessis, T. Lewis and L. Stewart

The main objective of the seed potato program at CDCN is to provide support to seed potato growers throughout Alberta. This is accomplished through research trials and extension services. The program works closely with the Alberta Seed Potato Growers Association to ensure that the needs of the industry are being met.

Seed Potato Repository. The purpose of AAFRD's seed potato repository is to maintain a collection of disease-free cultivars and lines to ensure that the Alberta seed potato industry has a source of plants for nuclear production. This is accomplished by multiplying disease-tested stock plants for private labs. In 1998, 34 public potato cultivars and accessions and 7 private cultivars were distributed to private laboratories across the western provinces for multiplication. Plant Breeders' Rights issues are becoming increasingly important and complicated in the Potato Industry and program staff have worked closely with private breeders and the Alberta Seed Potato Inc. to ensure that no problems arise in the future.

Research Projects

Enhancement of nuclear seed tuber production from plantlets

1998 was the final year of a three-year project designed to increase the efficiency of nuclear seed potato production. The greenhouse component of this study was completed in 1997 and this year's trials focussed on the effects of hormone application in the greenhouse on field production the following year and on the effect of tuber size on emergence and total yield. Final results are being compiled and a completed trial report will be available prior to planting in 1999.

Thank you Potato Development Incorporated and the Alberta Agricultural Research Institute for the funding they provided for this project.

Potato microtubers in seed potato production in Alberta

1998 was the first year of a two-year trial in cooperation with K. Pruski, entomologist and micropropagation specialist, CDCN. The project was designed to evaluate the potential role of microtubers in Alberta's seed production system and included laboratory, greenhouse and field components. The cultivars studied were Atlantic (chipper), Shepody (early frier) and Russet Burbank (storage frier).

Microtubers were produced in an aseptic *in vitro* laboratory environment and evaluated the use of a pre-treatment of jasmonic acid, jasmonic acid added to traditional media, and two lighting regimes (dark and 8 hours light). Russet Burbank responded most favourably to *in vitro* tuberization. Tubers were counted, weighed individually and diameter measured, then sorted and treated with gibberellic acid to break dormancy for planting in field and greenhouse trials. This dormancy breaking treatment proved to be insufficient and poor emergence in both the field and greenhouse made data collection difficult. Plantlets were the control for both the field and greenhouse trials as they are the current industry standard. Plantlets placed in the field the first week of June performed very well and, due to grower interest, more work will be done on this application in the coming year. In 1999, Ranger Russet and Umatilla Russet will be substituted for Atlantic and Shepody to see if their performance is comparable to Russet Burbank. A final report will be prepared at the completion of the study in the fall of 1999.

Gibberellic acid trial

Seed growers across the province have expressed interest in the use of gibberellic acid (GA) to increase tuber number and decrease average tuber size. This is common practice in the U.S., but no products are currently registered for this use in Canada. With the cooperation of Lewis Farms (Ranger Russet and FL 1833 seed), Groot Farms (Yukon Gold seed), Norac Concepts (Activol), and Agri-Trend Agrology Ltd (Stimulate), a replicated field trial was done in 1998.

The trial included an untreated control and a 10 ppm and 20 ppm GA solution made from either Activol or Stimulate for each cultivar tested. Solutions were applied as a seed treatment that was spayed onto tubers the morning prior to planting.

Initial results indicated that 10 ppm GA solution made from Activol increased tuber number and decreased average tuber size without decreasing yield. Stimulate, which includes the growth regulators cytokinin and Indole Butyric Acid in addition to GA, showed no significant effect, which may have been due to the growth regulators cancelling the effect of each other when applied as a seed treatment. Poor emergence of Yukon Gold made it difficult to associate any yield trends with the variety.

This trial will hopefully be repeated in 1999 and, with the cooperation of the PGA and Norac Concepts, have Activol registered for use in seed potato production. Preliminary results of this study were presented at the 1998 PGA Annual Meeting in Banff.

Variety demonstration trial

Potato varieties and selections maintained in our repository are grown in the greenhouse on an annual basis to ensure that the lines have remained pure and productive. Nuclear tubers produced at this facility are planted in the field for assessment of 'trueness to type'. Evaluation of potato cultivars is necessary to ensure that the Seed Potato Industry is being provided with a high quality seed source. This past year, the plot included 57 cultivars. Several different lines of the cultivars Russet Burbank, Ranger Russet, Shepody, and Norland were included to determine if one line or clone was superior or inferior to the others. Growers visited the plot during the Regional Trial tour and took the opportunity to look at the many cultivars that are in the repository. Visitors from Mexico were also interested in the demonstration trial as they were looking at chipping varieties that may be worth testing under their growing conditions. In 1998, the M.D. of Clearhills was supplied with 10 different potato varieties that were included in their alternative crop demonstration trial.

Prairie regional trials—early and main crop replicated trial

These trials are conducted annually in cooperation with the Lethbridge Research Station. They are an integral part of the AAFC Potato Breeding Program. New cultivars and accessions are compared with well-known standards to assess performance, maturity, yield, specific gravity, and culinary and processing quality. The observations are used to select new potato cultivars for the prairies.

CDCN was an early and a main crop trial site in 1998 and was also an irrigated and dryland demonstration trial site for 21 advanced selections and 8 industry standards. The early crop trial included 8 breeding lines and Atlantic, Carlton and Norland as standards. The main crop trial included 20 breeding selections for evaluation. Norland, Russet Burbank, Shepody, Atlantic and Snowden served as standards. Growers had the opportunity to tour the site on August 20th and Dr. Dermot Lynch of AAFC was on hand to answer questions about the advanced selections.

Technology Transfer Services

Co-organized the following seminars/workshops:

- Tissue Culture Course - for training growers in tissue culture and greenhouse production of woody plants and potatoes at CDCN.
- CDCN Field Day and Grower Tour

Participated in meetings and conferences:

- 30th Annual Potato Conference and 19th Ag Expo, Pocatello, ID
- Washington Potato Conference and Trade Fair, Moses Lake, WA
- Attended the 1998 Annual Meeting of the Potato Association of America, Fargo, ND
- Area meetings of the Potato Growers of Alberta
- PGA Annual Meeting, Banff, AB
- National Potato Council 17th Annual Seed Seminar, Seattle, WA
- Participated on AAFRD's Competitive Intelligence team examining the Mexican seed potato market and its long term potential for Alberta producers

The seed potato specialist provided extension services to growers and industry personnel through direct contact and presentation at meetings and conferences. The specialist also acted as a liaison with the Canadian Food Inspection to keep growers informed of regulatory changes.

Vegetable Crops Program (Brooks)

P. Ragan and W. Johnson

Applied field research and extension activities are designed to serve market gardeners, large-scale fresh vegetable growers, and contract processing growers. Variety adaptation and earliness enhancement of crops through improvements in cultural management practices are the main research activities of the vegetable program. Technology transfer is carried out through on-farm visits and participation in commodity organization conferences and workshops.

Research Projects

Variety adaptation

Detailed results of varieties tested were reported in CDCS Pamphlet 99-5 *Vegetable Variety Adaptation Trials 1998*. Copies were supplied to 30 participating seed companies. Workshops were held across the province in December to discuss findings and make recommendations to producers. These workshops also provided opportunities for producers to suggest priority areas for future research

Approximately 500 varieties of 17 types of vegetables were evaluated. In addition, succession plantings of direct seed and transplant cauliflower and broccoli varieties were evaluated. Storage quality observations on all carrot and onion varieties continued up to 6 months after harvesting.

Production management trials

Detailed results of production management trials, along with summaries were reported in the CDCS Pamphlet 99-4 *Vegetable Production Trials 1998*. A brief description of these trials follows.

Jumbo onion production

Jumbo grade onions are not grown commercially in Alberta from seed as the short season hinders full maturity. Limited success can be achieved with some selective cultural techniques. This trial was designed to investigate such methods. A randomized complete block design was used in this trial with the following treatments:

Cultivar — Top Rock and Tarmagon were selected because of their early maturity.

Density — a Stanhay Mark II drill with single-line belts was equipped to drop sufficient seed to provide a hand thinned count of 15 and 25 plants/m row.

The trial failed to achieve its major objective, the significant production of jumbo grade bulbs. This outcome was probably due to plant densities still being too high. Nevertheless, the following observations on onion production were made:

1. Earlier maturity occurs as plant density increases.
2. Overall yield increases as plant density increases; however, bulb size decreases as a consequence.
3. Jumbo grade bulbs can be produced with success only in single-line plantings with no more than 15 plants/m of row.

Romaine lettuce spacing trial

Of all the lettuce types, romaine has the best market potential in Alberta. This trial investigated this crop's performance at variable in-row spacings over three successive seedings.

In a randomized complete block trial, the varieties Parris Island and Valmaine were direct seeded and thinned to between plant spacings of 15, 30 and 45 cm. This same process was repeated twice more. Seeding dates were May 1 and June 3.

In the production of romaine lettuce and hearts as it relates to in-row spacing practice, the following was observed:

1. Parris Island was superior to Valmaine in yield and quality.
2. Closer in-row spacing of 15 cm compared to 45 cm enhanced maturity; however mean head and heart weight decreased.
3. There was greater variability in head weight as in-row spacing increased.
4. Recommended in-row spacing will be determined by market requirements for romaine head and heart weight.

Sulphur as an alternative method of root maggot control in rutabaga production

Rutabaga production in Alberta is severely hampered by serious attacks of two generations of root maggot during the growing season. Commercial insecticides have failed to control the pest and, in many cases, residues are persistent. In this trial, sulphur in a degradeable elemental form was tested because some reports of its maggot control properties in canola.

An unreplicated observational trial was conducted in which the commercial variety Laurentian was hand seeded on two dates: May 13, June 4. Seed was spaced every 10 cm in rows 5 m long and 1 m apart. At each seeding date, rows were treated with Tiger 90, a granular 0-0-0-90 sulphur fertilizer supplied by Tiger Industries Inc. Two methods of application and rates of

90, 180 and 360 lb/ac were used:

1. Seed and Tiger 90 were applied together in the seed furrow.
2. Seed was placed in furrow, covered with soil, then topdressed with Tiger 90.

Root maggot damage to all roots was severe regardless of treatment. Sulphur failed to provide protection and is therefore not recommended as an environmentally friendly, alternative control method.

Shoe (coulter) width impact on carrot rooting sizing

An extensive number of previously grown varieties, along with new entries, were direct seeded in a single row, non-replicated trial May 1. Rows measured 10 m in length and were spaced 60 cm apart using the raised-bed technique practiced by Alberta growers. Raw seed was direct seeded using a land wheel drive Stanhay equipped with twin-line seedbelts. Experimental treatments included:

1. 2.5 and 4.0 in. shoe (coulter) width
2. Hand thinned plant counts of 50, 60 and 80 plants/m (15, 18 and 24 plants/ft), thinned at the two-leaf seedling stage.

Shoe width treatments were planted in two separate blocks only to facilitate seeding. In each of these blocks, varieties and hand thinned plant counts within each variety were randomized.

At the July 21 harvest, all plants in each 1 m of thinned row were hand dug, topped, washed and graded. At grading, roots were counted and sized into three categories:

small	3/8 to 3/4 in. diameter
#1	3/4 to 1¼ in. diameter
jumbo	greater than 1¼ in. diameter

From each grade 10 random roots were measured for length.

The 4.0 in. (10 cm) wide shoe clearly increased root sizing and root length. Both wider coulter and higher plant counts increased yield overall. Optimum plant count cannot be recommended universally, but is rather specific to each variety.

Nitrogen and phosphorus rate influence on garlic production

This trial investigated the effects of spring application of nitrogen and phosphorus on the yield and bulb size of garlic. A simple randomized complete block trial was used with the following treatments:

Cultivar: Laszlo, a proven cultivar, a soft-necked artichoke type.

Fertilizer: nitrogen and phosphorus per acre interaction treatments of 100 x 200, 200 x 400, 300 x 200, 100 x 400.

This trial showed that garlic is not very responsive to nitrogen and phosphorous. Perhaps soil nutrient reserves were already adequate (N 202 and P 498). Although yield and bulb quality was not influenced when both nitrogen and phosphorous were applied together in early spring, fall application prior to planting needs to be investigated.

Technology Transfer Services

A one-to-one, on-farm extension service was provided to producers in the southern region of the province. Specialized equipment was loaned to producers to encourage adoption of new technology. Popular items included: two precision drills, transplanters and plasticulture equipment. Program staff also provided a seed belt punching and calibration service for producers using Stanhay seeders. Seed lots are matched with the best combination of belt hole size and number of holes to ensure optimum plant density in the field.

Annual workshops for vegetable producers were given to provide variety recommendations and guidelines to data interpretation as reported in the CDCS Pamphlets 99-4 and 99-5. These workshops also provided an opportunity for growers to comment on the direction of research programs.

Special activities included:
1. Carrot field day at CDCS, for producers.
2. Tour of four wholesale facilities in Calgary to assess market opportunities.
3. Tour of vegetable research plots at CDCS by produce buyers.
4. Supply chain linkages between growers and produce buyers were established for the 1998 season.

The Processing Vegetable Growers Newsletter was edited and posted quarterly.

Vegetable Crops Program (Edmonton)

B. Choban and C. McIsaac

The vegetable program at Crop Diversification Centre North (CDCN) provides the vegetable growers in north and central Alberta with extension and applied field research that responds to growers' needs, current market demand and the industry's development and growth. The ultimate aim is to increase the skills and knowledge of vegetable producers so they can become more competitive, increase their farm income and develop a self-reliant industry.

Research Projects

Research was concentrated on variety evaluations, crop diversification and production management. Research consisted of applied field trials on crops of greatest economic importance to the industry and was guided by industry demand. Kuhlmann's Market Gardens, Edmonton, provided substantial financial assistance toward a research fund set up by Alberta Agriculture Research Institute (AARI), to support the variety evaluation trials done at CDCN. Also many commercial seed companies supplied seeds for the variety trials. A detailed trial results report is available on request by contacting CDCN for report CDCN #98-V08 1998 Vegetable Variety Trials. Winter workshops were held with industry to share trial results and to discuss research priorities for next year.

Variety evaluations

Varieties were evaluated for yields, quality and maturity when grown in central Alberta. They included the following:

Broccoli - 11 varieties were direct seeded in late April, mid May and late May and evaluated for performance. Fine Green and Windsor showed early market potentials of good quality and good tolerance to field keeping in hot spells. Barbados followed closely behind. Laguna produced good quality and high yields for late harvests.

Mid season cabbage - 14 varieties were transplanted in earlier May. A new, early maturing, field keeping variety of good quality and a dense head with white interior was Ganzales, closely followed by August, Morris and Bronco. All appeared to be good for processing into kraut and cabbage rolls. The industry standard, Cecil, matures slightly later than these varieties.

Cauliflower - 18 varieties were transplanted early May, mid May and early June. The all round best performers throughout the season (in order of earliest to latest maturing) were Siria, Fremont and Cumberland.

Leaf Lettuce - 14 varieties were direct seeded in late April, mid May and late May. All varieties performed well. Some were more outstanding in appearance than others: Sierra was an attractive French Leaf type with a green heart and red tipped leaves. Nevada was an attractive Batavia type of similar colour. Cerize produced very attractive deeply lobed, dark red leaves. Red Salad Bowl, an oakleaf type, also produced deeply lobed leaves with a green butt and red top.

Fresh Peas - 8 varieties were evaluated. The best performing were: Northstar (regular sweet pea), Ho Lan Dow (snow pea) and Sugar Ann (sugar snap type).

Green Fillet Beans - 5 varieties were evaluated. Dorabel was a slightly shorter pod but outperformed all varieties in total yield.

Cherry Tomatoes - 8 cherry type tomatoes were evaluated. Red Alert was the earliest to mature showing good quality. Golden and Cherry Grande (in that order of maturity) produced attractive, tiny, very sweet tasting, yellow orange coloured fruit. Cheers produced a uniformed maturing harvest of very sweet and juicy small red tomatoes.

Squash - 9 varieties of an assortment of different types of squashes were evaluated. All produced well, including the winter squashes.

Hot Peppers - 8 varieties were evaluated. Super Chili produced the largest yield, the hottest pepper and was one of the first to mature. Giant Jalapeno and Super Cayenne also matured the earliest with good quality. Caribbean Red Habarero was an ultra hot variety but late to mature.

Garlic - 10 varieties of garlic were evaluated from a spring planting. All produced low yields and poor quality due to a hot dry spring. Vernon performed the best.

Specialty vegetables

Production of specialty vegetables offers diversification to large vegetable growers and a high-value crop to small growers. A variety of specialty vegetables of different varieties requested by the food service industry were grown and evaluated for production potentials as specialty crops. All the varieties performed well and showed potential for local production. They include the following:

baby beets - 5 specialty varieties
novelty cucumber - a lemon cucumber type; 15 harvests
braising mix - a variety of 6 different plants of salad interest; 5 seeding dates
kale - succession seeded late April, mid and late May.
endive - 5 varieties, 3 seeding dates
baby kohlrabi - 3 specialty varieties, 3 seeding dates
arugula - 3 varieties, 3 seeding dates
ornamental pumpkin - 3 mini varieties

Swiss chard succession seeding trial

Swiss Chard variety Bright Lights was succession planted every two weeks from April 28 to May 27 and evaluated for continuous harvest potentials. The data suggests that Swiss Chard be planted in late April, mid May and early June for a continuous supply of up to 4 harvests per season.

Integrated pest management approach in control of root maggots in cabbage crops in Alberta

Conducted a joint research project with the entomology program at CDCN in an integrated pest management approach in control of root maggots. The first year of a two year project received funding from Industry and AARI matching grant. Garlic Barrier, Tiger 90 (sulphur) and entomopathogenic nematodes were the alternative to chemical insecticides used. The data suggests good insect control properties from all. Further evaluations will be done by the entomology program next year.

The effects of booster frame plasticulture in horticulture

The first year of a 2-year Farm Demonstration project was conducted on a grower's field in co-operation with the grower and supported by the Farming for Future program through AARI. Plants were evaluated for yields, quality and earliness when field grown in high plastic tunnels referred to as Booster Frame Plasticulture. First year results indicated that marketable crop yields could be increased by at least 10%; crops mature 1-2 weeks earlier than traditional field planting methods; crops such as lettuce and spinach can be succession planted more times than traditional field production methods and harvests and market period can be extended by 1-2 weeks; and herb crops such as Basil can generate more than the normal field production of 2 harvests per season.

Processing of salsa and pesto for direct marketing from crops produced under plasticulture

The first year of a 2-year Farm Demonstration project was conducted in co-operation with a grower and supported by the Value Added Technology Transfer Program through AARI. Field peppers and field tomatoes where processed into salsa. Basil was processed into a herbal paste called pesto. The peppers, tomatoes and basil were grown under plasticulture to ensure product maturity and larger volumes of product available for processing. The processed products were direct marketed at a farmers market. First year results indicated that a guaranteed harvest of above normal yields of the basic products (peppers, tomatoes and basil) needed for processing into salsa and pesto was possible when using plasticulture. Results also showed that direct marketing of salsa was viable and that the product was popular with local consumers. But direct marketing of pesto was much more difficult due to the handling requirements (mainly refrigeration) and the promotion needed to encourage consumers to purchase it.

Improvement of fresh produce quality

The program co-operated with Agricultural Value Added Engineering Centre (AVEC) in their ongoing work with pre-cooling fresh vegetables. A small portable produce pre-cooler was built and demonstrated across the province on growers farms. Four fact sheets on vegetable pre-cooling including plans for a U-build portable pre-cooler are in the final stages of completion. A draft fact sheet on cost comparison for different ice machines is being worked on; and testing of different ice bed configuration continues. Final reports will be available from AVEC in the near future when work is completed.

Technology Transfer Services

Grower education and transfer of technical information in vegetable field production, product handling and marketing was conducted on a timely basis through the services stated below. Consultation, diagnostic problem solving, soil fertility recommendations and technology transfer to growers was maintained. Technology transfer was done through grower phone calls, office walk-ins, fax and E-mail responses, on-farm-site consultation, plot tours, seminars, courses and workshops

Plot tours were organized for Edmonton wholesaler buyers, Bejo and Seedway Seed Company representatives, individual growers, government extension staff, CDCN field day, and for an Agriculture Service Board tour. Assistance was provided to the department's Horticulture Product Team in organizing a tour of wholesale outlets in Calgary for the purpose of enhancing market opportunities for producers. A wholesaler farm tour of the Edmonton region was also organized to inform buyers of local production and product availability.

The program staff assisted AVEC with on-farm vegetable pre-cooling equipment demonstrations held across the province. Equipment demonstrations and loans of specialized equipment was done to encourage producers to adopt new mechanical technology. Approximately eight producers experimented with using the precision seeder, mechanical transplanter and mulch layer. The program leader contributed to a weekly crop report bulletin aimed at informing wholesale buyers on the current status of vegetable crops available for wholesale markets.

Close liaison continued with Alberta Market Gardeners Association (AMGA), commercial seed companies, Alberta Horticultural Congress and other industry personnel. AMGA sponsored an out-of-province direct market trip for the specialist. Advisory meetings for industry's input into the vegetable program were held in Taber and Edmonton.

Assistance to the industry for promoting the production of fresh vegetables continued through the Fall Harvest Festival vegetable donations and sales held annually at Fort Edmonton.

Consultation, co-operation and liaison with other divisions in the department that help contribute to the growth and development of the vegetable industry continued. Priority areas included action plans that the Horticulture Product Team addressed, reviewing loan proposals for growers and loan institutes and providing consultation and advice on diversification into vegetable crops for rural development and business development specialists.

New Crop Development Unit

This unit operates research, technology transfer and service programs in agronomy, plant breeding, soil and water management, food science, weed science, plant pathology and post-harvest technology. Support is provided to other research programs at CDCS and CDCN and to agricultural industries, producers and processors in Alberta.

Research and technology transfer programs are conducted in cooperation with the federal, private industry and university scientists. Close working contacts are maintained with various agricultural and scientific organizations outside Alberta.

Food Science and Technology Program

J.A. Panford, L.R.J. Dowdell, C. Turner and M. Hansen

The food science and technology program conducts applied research into current and emerging technologies in post-harvest handling, storage, and value-added processing of horticultural and special crops. Findings are transferred to Alberta's horticultural and special crops processing industries through presentation of research results at seminars, workshops and conferences and in trade and scientific publications. In addition, the program supports all crop production research programs at CDCS by carrying out chemical analyses and sensory evaluations on new and existing cultivars/varieties of fruits, vegetables, potatoes, pulses, herbs and spices.

Research Projects

Process and product development: native fruit quality

The program concluded the second year of a two-year study involving the evaluation of organoleptic characteristics of four saskatoon berry cultivars for commercial processing. The most widely grown cultivars Smoky, Northline, Honeywood and Thiessen were selected for this study. Both growers and processors were interested in knowing which cultivar is best suited for products such as jam, jelly, syrup, and pie filling and why. Attributes such as appearance, taste, texture, and overall acceptability were assessed for each cultivar and preparation of a final report is in progress. This project was jointly funded by the Alberta Agriculture Research Institute, Fruit Growers Society of Alberta, Saskatchewan Fruit Growers Association, and Prairie Fruit Growers Association of Manitoba.

Process and product development: fresh cut vegetables

The program completed work on Matching Funds Project #95M708, "Use of Modified Atmosphere Packaging Technology in Retail Packaged Fresh Pre-cut Vegetables." A final report was issued to the Alberta Agriculture Research Institute and the former Alberta Fresh Vegetables Marketing Board, who partially funded the project.

In collaboration with Dr. Dermot Lynch, potato breeder at the Agriculture and Agri-Food Canada Research Centre, Lethbridge, the Food Science and Technology Program evaluated the commercial processing quality (french fries and chips) of samples from the Potato Consortium Study. Results were forwarded to Dr. Lynch.

Process and analytical methods development: xanthophylls and carotenoids

The Program completed work on Matching Funds Project #96M943, "Determination of Carotenes and Xanthophylls in Alberta Grown Vegetables." A final report was issued to the Alberta Agriculture Research Institute, Edmonton and the Gimbel Eye Centre, Calgary.

In collaboration with Dr. Dermot Lynch, potato breeder at the Agriculture and Agri-Food Canada Research Centre, Lethbridge, the Program carried out analysis of reducing sugars in potatoes using High Performance Liquid Chromatography (HPLC) on the second year crop samples from the Processing Trial Research project. Results were forwarded to Dr. Lynch.

Service to Other Programs at CDCS

Program staff evaluated the quality of vegetables, potatoes and special crops for their suitability for commercial production, processing and human consumption.

- Essential oils extracted from herbs and spices grown by the special crops program at CDCS were analyzed for hydrocarbons by gas chromatography. Crops tested included catnip, monarda, coriander, caraway, peppermint, *Mentha arvensis*, spearmint, Alaskan mint and medicinal herbs. Results will be used in selecting cultivars for commercial production and processing.
- In support of the Prairie Potato Breeding Program and Dr. Colin McKenzie's Site-Specific Farming studies, potato cultivars and selections were processed and evaluated for their french fry, boiling, baking and chipping quality. Total glycoalkaloid content of selected cultivars was also determined. The results will be used in selecting cultivars for commercial production and processing.

Technology Transfer Services

The program leader attended and participated in AAFRD's Horticulture Product Team meeting in February and the Fruit Growers Society of Alberta's production workshop in March. The program leader then left AAFRD in May and a replacement is still being sought.

Plant Pathology Program

K.F. Chang, R.J. Howard, and M.A. Briant

The plant pathology program has a mandate to conduct applied research on important diseases of horticultural, special and forage crops. This research encompasses field, laboratory, growth chamber and greenhouse experiments, as well as disease surveys. Findings from this work and from the research of other scientists are presented to commercial producers through technology transfer programs. The plant pathology program also provides service in the form of support to crop production research programs at CDCS. Some plant pathology projects are also discussed in the report of the post-harvest technology program.

Research Projects

Diseases of Special Crops

Efficacy of seed treatments against bacterial blights on dry beans in field trials

Bluestone, Kocide LF, Copper 53W, Copper Oxychloride 50, Zineb 80W, Dithane M-22, Dithane DG, Agricultural Streptomycin and Vitaflo-280 were assessed for their ability to control seed-borne halo and common blight in Envoy and Viva beans. In Envoy, Streptomycin-treated seeds had the highest emergence, but also showed the highest incidence and severity of pod blight. Seed treatments containing metals, particularly copper, decreased disease incidence and severity in the pods compared to Streptomycin, but generally reduced emergence. In Viva, no significant differences in emergence, disease incidence and severity, and yield were detected between the products tested.

Efficacy of seed treatments against bacterial blights on dry beans in greenhouse trials

The chemicals used in the field trials described above were applied to seven cultivars in greenhouse trials to assess their effects on seedling emergence, plant height and root nodulation. Naturally-infested seed of Envoy was used, while seed of Othello, NW63, US1140, Viva, UI906 and AC Skipper were artificially infested. The seed was then treated with Vitaflo alone or in combination with Bluestone, Kocide, Copper 53W, Copper Oxychloride, Zineb, Dithane M-22, Dithane DG or Agricultural Streptomycin (check). There were no significant differences in nodulation or foliar blight ratings between treatments in any of the cultivars, except for Viva where Bluestone, Copper Oxychloride and Copper 53W resulted in nodulation ratings lower than Streptomycin. Disease incidence was higher in the Zineb versus Streptomycin treatment. Emergence and plant height for Zineb were greater than or equal to the eight other treatments and the untreated check in all cultivars, except Envoy. Bluestone and Kocide appeared to have the poorest performance across cultivars, while Copper Oxychloride, Copper 53W, Dithane M-22 and Dithane DG performed better or worse, depending on the cultivar.

Effects of fungicide seed treatments and rhizobium inoculants on emergence, plant height and nodulation of pulse crops

Four fungicides (Captan 400, Thiram 75 WP, Crown & Apron FL) and liquid, granular or powdered rhizobial formulations of six rhizobial inoculants (Tag-Team, N-Prove, Rhizup, Self-Stick, Nodulator & Bio Rhiz) were tested on dry bean, lentil, pea, fababean and chickpea (desi & kabuli). On drybean, Captan and Thiram improved emergence but had no significant effect on plant height or nodulation. Captan + Rhizup granular produced the best nodulation on kabuli chickpea, while Thiram + Rhizogen powder had better germination and plant height than the other treatments. Apron + Rhizup liquid had poorer emergence and smaller plant heights. The untreated check + Rhizup granular and untreated check + Rhizogen powder were better than Rhizup (liquid) and no rhizobium. On desi chickpea, Rhizup granular produced in the best nodule production. Captan and Apron produced better plant height and nodulation than Crown or the untreated check on desi chickpea. On pea, Apron had significantly better nodulation than the other treatments, while Rhizup granular was significantly better than the other rhizobia for nodule production. There were no significant differences in germination, plant height or nodulation among treatments in fababean.

Effects of copper products on germination and height of dry bean plants

Four copper fungicide/bactericide products [Bluestone (copper sulphate), Microcop-50 (copper oxychloride), Copper 53W (tribasic copper sulphate) and Kocide LF (copper hydroxide)] were applied at three rates (1x, 3x & 5x) as seed treatments, in combination with Vitaflo 280, to pink, pinto, black, large white and small red bean types. In general, there were no serious side effects on germination, except where Vitaflo 280 + Bluestone was applied to a small red variety. It showed poor emergence and reduced plant height, possibly due to a toxic effect of the chemicals.

Effects of copper products and rhizobium inocula on nodulation in pinto bean

Bluestone, Microcop-50, Copper 53W, and Kocide LF were applied at four rates (0, 1x, 2x & 3x) in combination with three rhizobial inocula [Rhizup (liquid), Rhizup (granular) & Rhizogen (self-stick)]. Nodule production was best with the granular inoculant, regardless of the copper bactericide used. None of the bactericide/rhizobium combinations had any serious side effects on germination.

Relative susceptibility of thirty-five cultivars of dry beans to halo blight in the field

Seed of nine types of dry beans were inoculated with halo blight bacteria, air dried and planted at Brooks and Bow Island. The most resistant cultivars in each category and yield responses were

Brooks

Large white - Beryl. There were no significant differences in yield among cultivars.

Pinto - Nodak. Nodak and Othello had the best yields.

Kidney -Moncalm and Foxfire. Foxfire had the best yield

Black - Nighthawk, Blackjack and Expresso. Nighthawk and Blackjack had the best yields.

Navy - AC Mariner. Fleetwood and Upland had the best yields.

There were no significant differences within the pink, small red, cranberry and small white types.

Bow Island:
Large white - Beryl and Ivory had the best yields.
Pinto - CDC Camino and UI 114 had the best yields.
Kidney - Montcalm, Foxfire and Red Kloud. All cultivars had significantly better yields than California Early.

Navy - Mariner. Fleetwood had the best yield.

There were no significant differences within the cranberry, pink, small red, black and small white types.

Relative susceptibility of thirty-five cultivars of dry beans to halo blight in the greenhouse

Thirty-five cultivars of nine types of dry bean were seeded into individual plastic pots and grown in a greenhouse at CDCS. Leaves were inoculated with halo blight using a needle dipped in suspension of halo blight bacteria. Susceptibility was determined by measuring lesion length on three leaves per pot. Types/lines and cultivars showing resistance to halo blight included: large white - Ivory and Beryl; pinto - CDC Camino; pink - Yolando and Viva; small red - NW 63; kidney - Montcalm, Foxfire, Red Kloud and California Early; black - Expresso; and navy - Mariner. The cranberry and small white classes could not be statistically analysed as there was only one cultivar of each.

Seed treatment and foliar application of Kocide LF to control halo blight (*Psp*) of dry bean

A blight-susceptible cultivar, Othello (pinto type), was sown in a field trial at Bow Island and six treatments were applied: 1. Control (clean seed, no foliar spray); 2. Inoculated seed (*Psp*) without foliar spray; 3. Inoculated seed (*Psp*) with early foliar spray; 4. Inoculated seed (*Psp*) with early & late foliar sprays; 5. Inoculated seed (*Psp*) with late spray, and 6. Inoculated seed (*Psp*) treated with Kocide and early and late foliar sprays. The use of Kocide LF for seed treatment, plus as an early and late foliar spray, provided the best control of halo blight, but there were no significant differences in yield among treatments.

Assessment of fungicidal seed treatments for the control of mycosphaerella blight of field pea

Trials were set up at Westlock and Mundare, Alberta. Seed (cv. Carrera) was selected from a 40% infected lot and treated as follows: Apron at 0.16 mL/kg seed. Thiram was added to two treatments at 0.75 and 0.90 g/kg seed, and Crown was added to three treatments at 0.85, 1.80 and 3.00 mL/kg seed. One seed lot was treated with Apron alone and one was left untreated as a control. All fungicidal seed treatments where Apron was combined with Thiram or Crown resulted in a greater number of emerged seedlings than the untreated seed lots at Mundare. Seed yield was improved over the control by Crown at the high rate of 3.0 mL/kg seed and Apron at 0.16 mL/kg seed. There was no significant ($P \leq 0.05$) difference in emergence or yield between controls and seed treatments at Westlock. Untreated seedlots ranked lowest in seedling emergence and seed yield at both sites. This was a cooperative trial with Dr. S.F. Hwang and G.D. Turnbull, Alberta Research Council, Vegreville.

Comparison of two Apron formulations for the control of root rot diseases of field pea

Seed of cvs. Carneval and Carrera treated with Apron XLS or Apron FL was sown at Brooks and Vegreville. Inoculum containing a mixture of *Pythium ultimum* and *P. irregulare* was incorporated at the time of seeding. Both fungicide formulations significantly ($P \leq 0.05$) improved pea emergence and yield. Fungicidal seed treatment had no effect on root rot severity at either site, but increased yield significantly in Carrera at both locations and showed higher yield at the Brooks location for Carneval. Inoculation with the *P. ultimum - P. irregulare* mixture significantly reduced emergence in both cultivars at Vegreville and in Carneval at Brooks. These results confirmed those from the previous year.

Efficacy of fungicides for the control of botrytis blight on chickpea

Two *Botrytis*-infested seedlots of the Kabuli-type chickpea cv. Sandford were planted at Brooks. Treatments consisted of Crown (3.0 and 6.0 mL/kg seed) + Apron FL (0.16 mL/kg seed); Apron (0.16 mL/kg seed); Vitaflo 280 (3.3 mL/kg seed) + Apron FL (0.16 mL/kg seed); and an untreated check. For seedlot #1, seed treated with Crown (6.0 mL/kg seed) + Apron combination resulted in a significantly better yield than those of the control and Vitaflo + Apron treatments. All the seed treatments significantly improved emergence and yield in seedlots #1 and #2, when compared to the untreated check.

Evaluation of Crown and Vitaflo 280 against fusarium root rot of ascochyta-resistant lentil

Lentil cvs. 512, Laird and Redwing were treated with Crown (3.0 and 6.0 mL/kg seed), Vitaflo 280 (3.3 mL/kg seed) or left untreated and seeded at Namao, Alberta. Untreated controls were seeded with and without *Fusarium avenaceum* inoculum. Both Crown fungicide seed treatments significantly ($P \leq 0.05$) improved the average number of emerged seedlings for cvs Laird and Redwing over the inoculated controls. None of the treatments significantly affected seedling emergence for cv. 512. Vitaflo 280 improved seedling emergence in Redwing. Seed yield was not significantly affected by seed treatment, except a higher yield for Redwing that was treated with Crown at 3.0 mL/kg seed.

Evaluation of Bravo foliar spray formulations against mycosphaerella blight on field pea

Experimental plots were set up at Westlock and Mundare, Alberta using cvs. Carrera and Montana. Foliar fungicide treatments consisted of Bravo 500 applied at 2 and 3.1 kg a.i./ha at early bloom and at 2 kg a.i./ha at mid-bloom, Bravo ZN applied at 2 kg a.i./ha at early and mid-bloom and Bravo WEATHER STIK applied at 1.75 kg a.i./ha at early and mid-bloom and a non-treated control. All fungicide treatments reduced disease severity on leaves throughout the plant canopy at Westlock, and all except Bravo 500 at the higher rate reduced stem infection. Bravo 500 applied to Montana at the lower rate reduced stem infection compared with the control and the Bravo ZN and WEATHER STIK formulations, and it improved seed yield over the control. Plots at Mundare were more heavily infected than at Westlock. All fungicide treatments resulted in lower foliar disease severity in mid-canopy for Carrera and, except for the higher rate of Bravo 500, resulted in less severe stem infection. No significant differences were observed between treatments and the control for Montana, except for a lower stem disease severity rating where the WEATHER STIK formulation was applied. This was a cooperative trial with Dr. S.F. Hwang and G.D. Turnbull, ARC, Vegreville.

Evaluation of foliar fungicides for the control of mycosphaerella blight of field pea

Eight foliar fungicide treatments were applied to cv. Carrera using different rates of BAS 500 (0.1, 0.15 and 0.2 kg a.i./ha) and Bravo 500 F (1.0 kg a.i./ha). All fungicide treatments significantly reduced disease severity on the lower leaves and stems compared to the untreated control, but there were no significant ($P \leq 0.05$) differences between control and fungicide treatments for disease severity on the upper and middle leaves. Yield was significantly improved over the control treatment with the application of Bravo (1.0 kg a.i./ha) at early and mid-flowering stages. Other fungicidal treatments did not significantly increase the yield of pea. This was a cooperative trial with Dr. S.F. Hwang and G.D. Turnbull.

Survey for foliar diseases on marrowfat field pea in southern Alberta

Nine commercial pea fields in Alberta were sampled in early August for foliar diseases. Ten plants per field were collected at random and diseases were identified based on symptoms appearing on the leaves and stems. Severity of mycosphaerella [*Mycosphaerella pinodes* (Berk. & Bloxam) Vestergren] blight was estimated visually using a 0-9 scale for each field surveyed. Powdery mildew (*Erysiphe polygoni* DC.) was rated as slight, moderate or severe. Stem pieces from each collection were surface-sterilized and plated onto acidified potato dextrose agar to determine the types of organisms present. *Mycosphaerella pinodes* was consistently isolated from infected stems. Mycosphaerella blight and powdery mildew were found in all nine fields surveyed. The average severity rating for mycosphaerella blight was 7.0, which was much more severe than previously reported. Powdery mildew ratings ranged from slight to severe. This disease was not present in southern Alberta in 1995. This survey indicated that mycosphaerella blight was widespread in irrigated crops and could have significant impact on the dryland pea production during wet growing seasons.

Survey of ginseng diseases in Alberta

Six ginseng gardens in central and southern Alberta were surveyed in July and September for foliar and root disease incidence (DI) and severity (DS). Since the summer weather was warm and dry, disease incidence and severity were lower than the past two years, but varied with location and age of the crop. Foliar DI ranged from 18.8 to 67.2%, while DS ranged from 0.39 to 1.48. Alternaria leaf spot was the most common disease in all gardens surveyed. Damping-off occurred in all 1- and 2-yr-old ginseng gardens surveyed. Roots harvested at Carmangay had the highest disease incidence (72.1%) followed by gardens located in Edmonton and Brooks. *Cylindrocarpon* spp. were the major cause of root infections followed by *Fusarium* spp., *Cladosporium* spp. and bacteria. *Alternaria* spp., *Penicillium* spp., *Rhizopus* spp., *Aspergillus* spp. and other fungi were minor pathogens. Nutrient deficiencies and powdery mildew (possibly *Erysiphe* spp.) were a minor problem in some ginseng gardens.

Survey for diseases in plantings of *Echinacea* spp. in Alberta

Five echinacea fields in Alberta were surveyed in July and August, 1998 and disease incidence (DI) and severity (DS) were determined. Diseased roots, stems, leaves and seed samples, except those with distinct symptoms of infection with *Sclerotinia sclerotiorum*, were returned to the laboratory for microorganism isolation. The DS and DI for both diseases varied with location and species of the crop. The DI for sclerotinia rot on *Echinacea angustifolia* (*Ea*) ranged from 0-16.0% and averaged 7.6%, while on *Echinacea purpurea* (*Ep*) it ranged from 2.0-34.1% and averaged 16.6%. The highest DI (70.3%), caused by aster yellows, occurred in a 2-year-old *Ep* crop at Brooks, while the lowest (0.2%) occurred in a garden at St. Paul. Damping-off caused by *Pythium* spp. and *Rhizoctonia solani* were found for the first time in 2-3 month-old seedlings of *Ea* in several greenhouses in the early spring. *Fusarium* spp. and *Alternaria* spp. were the two major fungal species isolated. Other microorganisms, such as *Penicillium* spp., *Pythium* spp., and bacteria, were also involved in root infection. *Cylindrocarpon* spp., *Botrytis cinerea* and *Aspergillus* spp. were isolated from root, stem and seed tissues, but in low percentages.

Evaluation of fungicides for the control of *Botrytis cinerea* on *Echinacea* spp.

Plants of *E. purpurea* and *E. angustifolia* were inoculated by spraying *B. cinerea* onto the leaves of the plants and then placing the plants in a mist tent for 24 hours. The plants were then removed from the tent, sprayed with Benlate (1/2000), Ronilan (1/1000), Rovral (1/1500), and Easout (1/2500) (fungicide weight/water volume; g/mL). The plants were placed on a bench in greenhouse for one week and number of infected leaves and lesion sizes were recorded for each treatment. Lower infection rates occurred on *E. purpurea* plants sprayed with Rovral than with other fungicide treatments. Lesions became quite large on the control treatment, but all fungicide applications limited lesion expansion.

Effect of leaf wetness on rust development on Scotch mint

The effect of leaf wetness on the development of mint rust was studied again by inoculating plants with rust spores. Inoculated plants were placed in a mist tent for various times ranging from 2-48 hours at 13 ±1°C, then were removed and placed in a greenhouse for 10 days. Pustules per leaf were counted for each wetness period. Pustule formation required 6 hours of incubation and increased with incubation period from 0.8/leaf at 6 h to 7.2/leaf at 10 h. Pustule formation remained stable between 10 and 36 h, but significantly increased after 48 h of incubation in the mist chamber.

Diseases of Forage Crops

Efficacy of two insecticides against silvertop on two cultivars of Kentucky bluegrass

Trials were conducted in 4-year-old field plots of Midnight and Cynthia Kentucky bluegrass at CDCS. Cygon 4E (at 425 mL/ha in 100 L water) and Decis 5.0 EC (at 200 mL/ha in 100 L water) were applied on May 19, May 27 and June 11. More than 25 species of insects were captured by sweeping the subplots from May 11 to June 19 on a weekly basis. In general, Decis was more effective at reducing silvertop incidence and insect populations than Cygon, especially in Cynthia bluegrass. These trials showed that controlling insects, especially plant bugs and leaf hoppers, helped to reduce or eliminate silvertop in Kentucky bluegrass.

Response of Kentucky bluegrass cultivars to powdery mildew under field conditions

Two trials were conducted at CDCS to screen cultivars of Kentucky bluegrass (KBG) for their resistance to powdery mildew. In one trial, 23 cultivars were seeded into two-row field plots and in the second trial, 21 cultivars of 3-year-old potted KBG plants were divided and transplanted into a single row per cultivar. Twenty-five leaves were randomly selected from each subplot and rated for disease incidence and severity based on a 0-3 scale. In the first trial, Nugget was the most resistant cultivar with 6% DI and 0.06 DS, followed by Ram I which had 19% DI and 0.20 DS. The most susceptible cultivars were Nuglade, Quantum Leap, Reubens and Common, each of which had more than 94% DI and 2.0 DS. For the transplant trial, Indigo, BO-141, Ryss were highly resistant to the disease, while Barvb985, Abbey, Amazon, Geranimo, Alene, Bluestar, Baron and Adelphi were the most susceptible.

Diseases of Vegetable Crops

Effects of fungicides and insecticides on rhizoctonia root rot of cauliflower

The cultivar Fremont was used to study the effect of five fungicides and three insecticides, combined with Benlate, on the development of root rot and vegetative growth of cauliflower. Overall, fungicide-treated cabbage had smaller lesions than untreated plants. Benlate showed the best control of the five fungicides used, and Diazinon + Benlate achieved the best control of root rot of the three insecticide-fungicide combinations tested. This trial confirmed the results of the previous year.

Evaluation of cauliflower cultivars for resistance to rhizoctonia root rot

Twenty-one cultivars of cauliflower were screened for resistance to *Rhizoctonia solani* under field conditions. Seedlings were grown in Root Trainers for about one month, then transplanted into the field. Approximately 0.5 g fungal inoculum was placed around the basal portion of each plant. Two weeks later, each plant was drenched with 200 mL of fungicide solution. During harvest, plants were pulled and basal portions of stems were cut to examine the internal lesion length. Significant differences in stem lesion length occurred between plants in the inoculated and non-inoculated treatments. Cultivars that had the best resistance were Flora Blanca 18, Wentworth, Sierra Nevada, Serrano, Apex and Cumberland. Head weight was significantly lower in Vio-Queen and Bur-Queen than in other cultivars.

Evaluation of cole crops and radish for resistance to *Rhizoctonia solani*

Greenhouse trials were conducted to determine the resistance of cole crops to *Rhizoctonia solani*. The trial included 21 cultivars of cauliflower, 34 cvs. of cabbage, 19 cvs. of broccoli and 15 cvs. of radish. For pre-emergence damping-off trials, the cultivars were sown in sterile soilless mix containing 500 mL of *Rhizoctonia* inoculum per 10 L. For post emergence damping-off trials, seeds were sown into sterilized soilless mix. When the plants reached the first true leaf stage, 0.5 g of inoculum was placed at the base of each plant, then covered with another layer of sterilized soil. Non-inoculated soilless mix and plants were used as a control. Cultivars varied in their resistance to the pathogen within each crop species. The most resistant broccoli cultivar was Cruiser, which showed 20% post-emergence damping-off (DI) and disease severity (DS) of 1.85. For cauliflower, radish and cabbage, the most resistant cultivars were Cumberland (DI=31%, DS=2.13), Red Boy (DI=20%, DS=1.90), and Blue Vantage (DI=10%, DS=2.10), respectively.

Technology Transfer Services

Program staff spoke at ten growers' and professional meetings in 1998. The English and French versions of *Diseases and Pests of Vegetable Crops in Canada* continued to sell well throughout the year. Four scientific papers, four abstracts and 20 miscellaneous reports were published. Staff were involved in the activities of several professional societies and advisory committees. Assistance was provided to Brooks Diagnostics Limited to diagnose several dozen plant disease specimens. As well, advice on disease identification and management was provided to Centre staff as requested.

R.J. Howard retained an appointment as an Adjunct Professor in the Department of Agricultural, Food and Nutritional Science at the University of Alberta, and was involved in Departmental activities including lectures, diagnostic consultations and cooperative research. He was President of the Canadian Phytopathological Society in 1997/98.

K.F. Chang was elected as one of the directors of the Alberta Ginseng Association Board. Both R.J. Howard and K.F. Chang also served as committee members of the Prairie Registration Recommending Committee on Grains and Western Committee on Plant Diseases.

Post-harvest Technology Program

J.D. Holley and S. Lisowski

The primary objective of the post-harvest technology program at the CDCS is to maximize the longevity and quality of stored horticultural crops. Research and extension efforts are both directed towards improving storage management practices used in industry today. In addition to this, the program routinely screens advanced breeding lines from the Prairie Potato Breeding Program for levels of resistance to early blight, to verticillium and fusarium wilts, and to a range of storage diseases and physiological disorders.

The post-harvest technology program worked on several unique projects last year. It received potatoes from six different provinces for post-harvest screening. It continued to work with alfalfa blossom blight and began evaluating a new biological control agent, *Coniothyrium minitans*. Last fall the program began working on a sugar beet storage research project designed to document losses of sucrose in beets exposed to repeated freeze/thaw cycles after harvest.

Research Projects

Field Trials

Early blight resistance screening

Replicated small plots of two standard cultivars and twenty-five advanced breeding lines from the Prairie Potato Breeding Program were planted in soil that was heavily infested with spores of the early blight pathogen, *Alternaria solani*. The percentage of each row infected with early blight was estimated several times during the summer and the observations used to construct apparent infection rates for each small plot. Five lines developed early blight symptoms as slowly or more slowly than the resistant standard, Russet Burbank, six developed blight as rapidly or more rapidly than the susceptible standard, Warba. The rest had moderate rates of infection.

Early blight survey

Many potato growers in southern Alberta complained about unusually severe early blight last summer. Of interest was the fact that the disease developed relatively slowly at the resistance screening trials described above, even though weather conditions at CDCS were similar to conditions in fields with severe infection. New, aggressive strains of *A. solani*, the early blight pathogen, may have caused the problem. A survey was conducted last August to test this hypothesis. Leaves with early blight were collected from fields with different rates of infection. Isolates of *A. solani* were recovered from each field in the survey. Single spore isolates will be compared using DNA sequencing and the aggressiveness of each determined in greenhouse and field trials in 1999.

Verticillium wilt resistance screening

Virulent cultures of two potato wilt pathogens, *Verticillium albo-atrum* and *V. dahliae*, were grown on barley seed three weeks prior to planting. Replicated small plots of two cultivars and ten advanced breeding lines were planted with infested grain. Fifty tubers from each replicate were cut and examined for evidence of vascular browning from wilt infection after harvest. One test line had less and three others as much discolouration as the resistant standard, Russet Burbank. None of the breeding lines had as much vascular browning as the susceptible standard, Shepody. Six lines had intermediate levels of disease resistance, i.e. higher levels of vascular browning than Russet Burbank but less than Shepody.

Fusarium wilt resistance screening

A virulent culture of *Fusarium oxysporum* was used to inoculate two cultivars and ten advanced breeding lines in a second wilt screening trial. Two lines had as much vascular discolouration as the resistant standard, Russet Burbank. One breeding line had as much vascular browning than the susceptible standard, Shepody. Seven lines showed intermediate levels of disease resistance.

Evaluating cultivar resistance to alfalfa blossom blight in the field

Small, replicated plots of seventeen alfalfa cultivars were planted at the McLeod farm at CDCS. Different cultivars showed different levels infection from both of the blossom blight pathogens, *Sclerotinia sclerotiorum* and *Botrytis cinerea*. Results will be compared to data collected next summer before any conclusions are made.

Laboratory and Greenhouse Trials

Evaluating cultivar resistance to two alfalfa blossom blight pathogens in the greenhouse

The seventeen alfalfa cultivars that were tested in the field at the McLeod farm, were planted in the greenhouse and inoculated with *S. sclerotiorum* or with *B. cinerea* when they were in full bloom. Recovery rates were high for some cultivars and moderate to low for others. Mature flowers had much higher levels of infection than leaves or stems. The response of all tissues from each cultivar were similar, i.e. if recovery rates were high for flowers then they were also high for leaves and stems. The fact that cultivars responded differently to infection from *B. cinerea* and *S. sclerotiorum* in controlled conditions in the laboratory and in replicated field trials suggests that genetic resistance probably will be used in the future to control this disease.

Storage Trials

Consortium storage trial for processing quality and disease resistance

Thirty-six breeding lines from the Prairie Potato Breeding Program were tested last fall for disease resistance, durability and for baking, fresh market and processing quality. Half of these potatoes were loaded into CES rooms with stable storage conditions at 6, 8 or 10° C. Samples were taken from each of the three stable CES rooms every two months to determine effects of temperature on chip, french fry, baking and boiling colour and texture. To date, potatoes in the 8 and 10° C CES rooms have retained good processing quality; however, quality of potatoes from most of the test lines degenerated quickly at 6° C.

The other half were put into a CES room at 8° C with fluctuating levels of temperature and humidity. Tubers in the unstable 8° C CES room were subjected to stressful conditions to see how resistant they were to diseases that become more severe in storage after harvest, e.g. late blight, leak, silver scurf and pink, dry and soft rot decay. Tubers were also examined for evidence of susceptibility to bruising, cutting, discolouration or any other physiological disorder. Different cultivars/breeding lines did have different levels of diseases and disorders.

Effect of cultivar and storage conditions on silver scurf infection on potato after harvest

Half-tonne pallet boxes of commercial potatoes were harvested and then loaded either into a cool-down CES treatment rooms in which temperature decreased at a steady rate of 0.016° C per hour (1.7° C per week) or into a CES room in which temperature was lowered in incremental steps of 1.7° C once each week over a three to four hour period. After all of the field heat had been removed, tubers from each cool-down room were divided into three equal lots. One-third of the potatoes were put into a long-term room with low levels of relative humidity (80-85%) and two- thirds into one of two rooms with high levels of humidity (90-95%).

Temperature and humidity levels were steadily maintained in the room with low levels of relative humidity and in one of the rooms with high relative humidity. The temperature was programmed to fluctuate in the second high humidity room. The highest levels of disease were found in the CES room with unstable conditions. Lowering humidity levels from 95 to 85% in stable CES rooms only marginally reduced levels of silver scurf. Silver scurf developed at very different rates on different cultivars stored side by side in the same CES room.

Testing the efficacy of azoxystrobin on stored potatoes

Azoxystrobin (Anvil) was applied at five rates (0, 1.5, 3.0, 4.5 and 6.0 g ai/L) in a spray volume of 1 L/t to eight 50 kg lots of commercially grown Norchip and Russet Burbank potatoes. Half of the sprayed potatoes were put into a CES room with stable conditions and the other half into a CES room with fluctuating conditions. Although all of the observations from these experiments were recorded, the data analysis was not completed in time for the annual report.

Effect of foliar applied metalaxyl in reducing decay from leak and pink rot

Small replicated plots of potatoes were planted at sites in British Columbia, Manitoba, Ontario, Quebec and Prince Edward Island (PEI). Plots were either sprayed with mancozeb (Dithane), chlorothalonil (Bravo), propamocarb hydrochloride + mancozeb (Tattoo C + Dithane), metalaxyl + mancozeb (Ridomil MZ + Dithane), purified metalaxyl + mancozeb (Ridomil Gold + Dithane), purified metalaxyl + chlorothalonil (Ridomil Gold + Bravo) or with water every 7 to 14 days during the growing season. Potatoes from each plot were shipped to CDCS for post-harvest testing. Potatoes were stored for four months in a CES at 8°C and 95% relative humidity. Half were then inoculated with *Pythium ultimum*, the leak pathogen, and the other half with the pink rot pathogen, *Phytophthora erythroseptica*. Analysis over all test sites showed that application of fungicides reduced levels of decay from leak and pink rot two weeks after inoculation. Potatoes sprayed with purified metalaxyl + chlorothalonil, however, had levels of decay up to 65 to 70% lower than the check. Although the effect of this treatment was seen all test sites, reduction in the level of decay was greatest where levels late blight had been high during the growing season, i.e. in PEI and Quebec. Results from this cross-Canada trial need to be verified.

Testing the efficacy of fludioxonil, a new seed piece treatment for potato

The program evaluated a second cross-Canada storage trial in 1998. In this trial, replicated small plots of potatoes were planted in three provinces, i.e. Alberta, Ontario and PEI, after being coated either with 0, 1.75 or 2.5 g ai/500 g of fludioxonil (Maxim), or with thiophanate-methyl (Easout) or mancozeb (Tuberseal) at label rates, or with talcum powder. Potatoes from all small plots were harvested, shipped to CDCS and loaded into an 8°C CES storage room with fluctuating conditions. Levels of black scurf, dry-rot and silver scurf were recorded for each tuber after twelve months storage. Applying fludioxonil at the lowest rate reduced levels of black scurf and dry-rot in storage on potatoes from every test location. Application of the highest rate of fludioxonil was needed to significantly reduce levels of silver scurf. Unfortunately levels of disease control varied from one site to next for silver scurf. Different cultivars were grown at each test site, so genetic resistance probably confounded the silver scurf data. Efficacy data from this trial formed a major part of a new registration package submitted by Novartis for review earlier this fall.

Effect of bleach dip treatments on stored carrots

A storage trial was set up to determine how bleach dip treatments and post-harvest conditions affect the moisture, colour, sugar content, taste and level of disease of cellophane-bagged carrots. Caro-Choice, Eagle and Kamaran, were grown for the trial at CDCS, harvested mechanically into ½ tonne pallet boxes, and loaded in bulk into CES rooms at 2°C with levels of relative humidity at 95%. Carrots were removed from the pallet boxes, washed, dipped into 0, 0.01, 0.05, 0.1, 0.25, 0.5 0.75, 1.0, 10 or 100 ppm of sodium hypochlorite, dried and packaged into two one kilogram cellophane bags. Half of the carrots were stored at 2°C in a CES room with humid stable conditions and the other half in a CES room with unstable conditions. Levels of decay from sclerotinia white and botrytis grey molds were much higher in the CES room with unstable conditions. Carrots in the CES room with stable conditions showed very little decay even after twelve months of storage. Preliminary results from the last two seasons indicate that dipping carrots into solutions of chlorine greater than 1% adversely affected taste, sugar content, colour and appearance. Results from this season's experiments will be combined with data from 1996 and 1997 to determine which bleach concentration prevented storage decay the best.

Effect of a new biological control agent, *Coniothyrium minitans*, on white mold of carrot

A new storage trial was set up to see if the application of the mycoparasite, *Coniothyrium minitans*, effectively reduced levels white mold decay, caused by the pathogen *Sclerotinia sclerotiorum*, on stored carrots. Field grown carrots (cv. Eagle and Kamaran) were carefully washed, rinsed, dried, sprayed with suspensions of *C. minitans* at rates of 0, 10^5, 10^6, or 10^7 spores per millilitre, allowed to dry a second time, then packaged and stored as outlined in the previous report. Levels of *S. sclerotiorum* decay were lower on carrots sprayed with suspensions of 10^7 spores per millilitre than on carrots from the check after three months of storage. The same effect was observed four months later. Carrots will be examined once more next spring to see if disease control is sustained.

Effect of freezing and thawing on sucrose levels in stored sugar beets

The Post-Harvest Program received eight ½ tonne pallet bins of freshly harvested sugar beets at the end of October. Four bins contained healthy beets and four were filled with beets that had been cut and bruised at harvest. Eight pallet bins were organized into pairs. Each pair of pallet bins had healthy and damaged beets. The first pair was loaded into a stable CES room at 4°C and 95% relative humidity, the second into a freezer at -20°C, the third into a CES room programmed to simulate outside temperature fluctuations for a warm winter, and the fourth into a CES room programmed for moderate winter conditions. Four beets were removed at random from each pallet bin as they were being loaded in storage. The water and sugar content were determined for each beet. Water and sucrose levels will be recorded for beets in each bin as described above every four to six weeks for the duration of the experiment.

Technology Transfer Services

Routine queries about potato and vegetable diseases and about storing potatoes, carrots and other garden vegetables were dealt with as they arose. The program leader worked closely with staff from Novartis, the AdCulture Group and with research scientists in Manitoba and New Brunswick last spring to put out a new extension bulletin on diseases of stored potatoes. The bulletin had a number of colour photographs and was distributed to producers all across Canada.

The Post-Harvest Program leader received a request from Agriculture and Agri-Food Canada inspectors for help in identifying diseases that occur on alfalfa in the field. He took inspectors on a survey, collected plants that had a range of symptoms and isolated the causal agent(s)from each symptom in the lab. Inspectors took pictures of each symptom and pressed plant material of each. A report clearly identifying causal agents was sent to the inspectors for future reference.

The Post-Harvest Program ran a series of microbiological tests to check the purity of a new frozen potato product manufactured for the first time last spring by Bassano Grower's Co-operative (BGC). Results from these tests helped the producer improve product quality. Test results also helped the producer begin to export the new product to wholesalers in Japan.

A significant amount of time was taken to determine why a number of potato growers in Alberta and Manitoba were sustaining such serious economic losses from extensive dry rot decay in storage. Culture and sensitivity tests showed that resistance had developed in both provinces to two fungicides that are used routinely to control dry rot. Growers were encouraged to stop relying so heavily on fungicides and to start taking more precautions earlier in the season. Growers in Manitoba were having difficulties in accurately identifying leak, dry and pink rot on their stored potatoes, so time was taken to help them. There seems to be a need for more education and extension in this area. Efforts will be made to put out an new extension bulletin on leak and pink rot in co-operation with Manitoba's provincial pathologist, Dr. Gary Platford.

The Post-Harvest Program leader presented a paper titled, "*Efficacy of fludioxonil, a new seed piece treatment for potato*", at last fall's joint annual meeting of Prairie Potato Council (PPC) and Saskatchewan Potato Seed Growers Association (SPSGA). He also assisted in editing and updating the potato chapter for "*Guidelines for the Control of Plant Diseases in Western Canada*". He continued to participate on the Alberta Potato Research Committee (APRC) and on the Storage Committee of the PPC. Last year the program leader served as past-president for the Plant Pathology Society of Alberta (PPSA).

Soil and Water Agronomy Program

R.C. McKenzie, S.A. Woods and L. Hingley

The soil and water agronomy program conducts research on water and fertilizer requirements of special crops, horticultural crops and irrigated forages. Some research projects were done cooperatively with staff from other programs at Crop Diversification Centre South (CDCS) and other divisions of Alberta Agriculture, Food and Rural Development (AAFRD). Soil samples were analyzed by AAFRD's Soil and Crop Diagnostic Centre, Edmonton. Research funding was provided by the Alberta Agricultural Research Institute's (AARI) Farming for the Future Matching Grants Research Program, the Potato Growers of Alberta, The Potash and Phosphate Institute of Canada, Viridian, Westco, Cargill, Southern Agri Services, Old Dutch Foods and Canadian Snack Foods Association. Farmers who cooperated with field research projects were E. and J. Stolk of Taber, J. Rozendall of Hays and R. Wickkerink from Bow Island.

Research Projects

Precision Farming

Salinity tolerance of dry beans

The purpose of this project is to measure the yield reduction of beans which occurs on saline soils. With newly available commercial services for mapping, it will be possible for farmers to map their fields and then decide what areas are suitable for growing salt sensitive crops such as beans.

In September, 1998, a 54 ha field of dry beans which contained some saline areas was mapped for salinity using an EM38 salinity meter and Global Positioning System (GPS) technology. A yield map of beans was made using a yield monitor system on the combine. A relationship between yield and salinity will be developed and compared to a relationship determined on another field in 1997.

Site-specific management of potatoes

Site specific management is applying different amounts of inputs such as water, fertilizers, herbicides to different portions of a field. This is now feasible using global positioning technology controlling equipment such as fertilizer applicators or herbicide sprayers. It can also be done at a less technical level by subdividing the field into different units and applying different inputs to each unit.

This project commenced in 1996 and will continue until 1999/2000. The objectives are:

- to measure and map yield variability within a field
- to determine the effects of soil type, landscape position, soil fertility, diseases and weeds on yield
- to determine the variability in yield of preceding crops, and to relate this to field variability and tuber production
- to measure the cost benefits and environmental influences of site-specific management
- to evaluate the use of remote sensing and digital image analysis of fields to detect nutrient deficiencies and diseases of potatoes

Two, 27 ha potato fields were monitored in detail. One was irrigated with a centre pivot and the other with a corner pivot. Soil texture was determined at 48 points and, at these points, rainfall, irrigation and soil moisture records were taken weekly and plant petiole samples were taken three times during the growing season for nutrient analysis. Yield data and remote

sensing imagery were also collected and compared to soil and crop characteristics to explain what caused variations in yield.

The project showed that soil texture, tissue nutrient content and the available soil moisture status of potato fields were quite variable. Tissue phosphorus, as well as nitrogen, declined rapidly during the growing season in portions of the potato fields. The potatoes were deficient in tissue potassium in early July, 1997, on both fields, but there was adequate potassium on both fields at the end of July and in August. Low soil temperature is known to reduce the uptake of potassium. In 1996, soil moisture was lower under the outer portions of the center pivot and on the corners of the corner pivot system. In 1997, the centre pivot system was converted to a low pressure system and, as a result, water application was higher on the outer part of the system and lower near the centre. The yield was determined on strips which received various rates of nitrogen and phosphorus fertilizer. In the fall of 1998, two rates of each of compost, manure and phosphorus were applied to one field.

Soil Fertility

Fertilizer requirement of irrigated alfalfa

In 1994, an experiment designed to determine the response to fertilizer application in irrigated alfalfa was begun. This project was jointly funded by the Alberta Agriculture Research Institute (AARI) Matching Grants Program, the Potash and Phosphate Institute of Canada, Westco Fertilizers and Sherritt Fertilizers, and with the co-operation of six alfalfa hay producers in southern Alberta. The object was to determine if fields which tested low in soil phosphorus and adequate in tissue phosphorus would respond to phosphorus fertilization. Also, three of these fields, which tested adequate in soil potassium and low in tissue potassium, were tested for a response to potassium fertilization. Low rates of nitrogen were also tested on alfalfa. In 1996, four of the original six fields were taken out of production and three new fields, which were low in phosphorus and potassium, were added. The results indicated:

- Some fields showed a small but positive response to nitrogen.
- Broadcast phosphorus was equal to shallow-banded phosphorus.
- After 3 years an annual application of phosphorus yielded more than a single batch application once in three years.
- A combination of soil tests and tissue tests appeared to be the best way of measuring the need for phosphorus fertilizer.
- Potassium fertilization did not give a significant increase in yield on fields which tested low in tissue potassium.

Controlled-Release Fertilizers for Container-Grown Woody Plants

The soil and water agronomy program co-operated with the nursery crops program with this project. Three rates and four combinations of 8-9 month and 3-4 month, coated, slow-release fertilizers, along with a control treatment of a water-soluble fertilizer, were used. Marigolds were grown in a growth chamber. For further details of this project, see the report in the nursery crops program section of this report.

Investigation of the growth of two species of field-grown trees at different nitrogen fertilizer rates

The soil and water agronomy program co-operated with the nursery crops program with this project as well. Field-grown plant material provides about $11.2 million in sales to Alberta growers. There is inadequate information about management of fertility to provide maximum growth and still avoid over fertilization which may cause dieback or winterkilling of trees.

Colorado blue spruce and green ash were planted in 1997 at Brooks and Edmonton and four rates of soil nitrogen were applied at each site. No significant differences in growth were observed in 1997 and 1998. For further details of this project, see the report in the nursery crops program section of this report.

It received financial support from the AARI, Arrowhead Nurseries, Edmonton, and the Alberta Ornamental Plant Foundation.

Technology Transfer Services

Soil and water information was provided to a diverse audience through scientific papers, technical reports and research publications. Presentations were made at technical conferences and producer meetings and inquiries were answered through telephone contacts, office visits and correspondence.

The yield monitoring projects attracted a lot of attention from the media and various agricultural industries. Presentations on this project were made at a number of meetings, and in agricultural publications. Information on crop tolerances to salinity and methods of measurement was provided to farmers, extension personnel and researchers. Manure management information was provided to AAFRD staff who were revising the Manure Management Code of Practise. Information on water use and protein content of various types of wheat was used in several publications.

Special Crops Program (Brooks)

R. Gaudiel, C. Wildschut, E. Russell and L. Ost

The special crops program at CDCS, Brooks is primarily responsible for the development of alternative and new crops for Alberta through applied research and technology transfer. This meets the ministry's goal towards crop diversification and competitiveness. The program also provides service to other departmental staff and to commodity organizations as consultants, through cooperative, regional varietal tests and demonstration plots, and by providing materials and advice to interested parties.

Detailed project results are presented in CDCS pamphlet 99-20, *Special Crops Cultivar Trials*.

Research Projects

Drybean cultivar evaluation and cultural practices

Ten yield tests with various drybean lines and varieties were conducted at Brooks and Bow Island under irrigated conditions to gather data for screening, registration and recommendation purposes. Growth and development of the bean plants were excellent due to a warm and longer than normal growing season and enabled most plants to reach maturity. Some excessive water damage in the Bow Island sub-station plots occurred.

Several new varieties and lines were developed by the bean breeding programs in Lethbridge (Agriculture and Agri-Food Canada) and in Saskatoon (Crop Development Centre) that were upright in growth habit and high yielding. Most were also as early or earlier maturing than the standard commercial varieties. Five new dry bean lines, consisting of one pinto, one great northern, two pink and one small red type were recommended for varietal registration by the Prairie Registration Recommending Committee on Grain (PRRCG). The availability of these upright and early maturing varieties opens up the possibility of seeding beans in a narrow row configuration, harvesting by straight combining and expanding beyond the present area of production. In 1998, 6 locations in southern Alberta were used to test the newly registered varieties under irrigated conditions. AC Earlired (small red) and AC Alberta Pink (pink), varieties developed at the Agriculture and Agri-Food Canada station at Lethbridge, yielded significantly more and matured earlier than NW 63 and Viva respectively in the wide row tests. In the narrow-row tests CDC Pinnacle and CDC Camino, pinto type varieties developed at the Crop Development Center, Saskatoon, out-yielded Othello by almost 150%.

Other pulse crop cultivar evaluations and cultural practices

Five fieldpea cultivar trials were conducted at Brooks, Bow Island and Standard to evaluate lines and varieties for screening and regional adaptation purposes. The most promising new lines and varieties continued to come from European breeding programs. A number were relatively early maturing, semi-leafless and upright in growth habit. A record twenty-six fieldpea lines, i.e. fifteen yellow and eleven green-seeded types, were recommended for varietal registration by the PRRCG. They were generally higher yielding than the current standard varieties, had equal or higher protein content and were generally early maturing, with acceptable disease resistance and quality characteristics. Again in 1998, 22 sites in Alberta and the Peace region of British Columbia were used to test new registered fieldpea varieties. Some of the varieties that yielded significantly better than the check variety Carneval, were Alfetta, Baccara, Bridge, Delta, Eiffel, Espace, Miami, AC Melfort and Nicole.

Different lines and registered varieties of other pulse crops, such as lentils, fababeans, chickpeas and soybeans, were again evaluated for registration and for regional adaptation. The soybean cooperative test was abandoned due to poor germination. Most new lentil varieties continued to perform well in Alberta. A number of kabuli- and desi-type chickpea lines from the Crop Development Centre at Saskatoon were early enough to mature and yielded satisfactorily.

Other special crop cultivar evaluations and cultural practices

Several cultivars and lines of millet, canaryseed, mustard, safflower and hybrids of sunflower and corn for grain and silage were evaluated for potential registration and regional adaptation. In 1998, the mustard varieties Tilney, AC Pennant and Gisilba were the highest yielding of the yellow mustards. Forge was the highest yielding of the brown mustards. The grain and silage corn tests at Brooks evaluated 11 and 25 hybrids, respectively. The confectionery sunflower hybrids Dahlgren 151, Pioneer 6946 and Sigco 974 were the highest yielding amongst 17 entries tested at Bow Island.

New crop adaptability

Different lines and selections of grain amaranth and fenugreek were evaluated for adaptability by measuring maturity and yield at Brooks and Standard respectively. There were a few lines of grain amaranth that were early enough to mature properly in Alberta. A few selections of fenugreek yielded as well and matured as early as the standard variety.

Adaptability, cultivar development and agronomic studies of essential oil, spice and health promoting crops

The purpose of this project was to evaluate promising lines and selections, to develop management practices for selected spice and aromatic crops, and to evaluate the adaptability of various lines/selections of other health-promoting plants, particularly ginseng.

Studies on the effect of different types of planting stocks on peppermint and spearmint performance and the tolerance of several field crop species planted in terbacil, (a persistent herbicide used in mint production) treated soil was continued at Brooks. The effect of using different planting stocks on the biomass and essential oil yields of both mint types have been completed except for analysis. Crops that appeared to have greater tolerance to terbacil residues were field peas, followed by corn. Canola was the most susceptible. Plowing a field previously treated with terbacil helped reduce the damaging effect of the herbicide.

This was the second year of observing the emergence and growth of ginseng seeded in the fall of 1996 at Brooks. The number of plants emerging from beds covered with either 5 or 10 cm of straw were similar. However, when the beds were permanently mulched with 15 cm of straw, emergence was reduced. Covering with a thermal blanket a bed already covered with 5 cm of straw enhanced seedling emergence in the spring. Unfortunately, seedlings that emerged early were damaged by a late spring frost. Date of straw removal affected the date of emergence of ginseng, but not the total number of plants that emerged. The earlier the straw was removed, the earlier the seedlings emerged. The Goldenseal rootlets planted in the same beds in the fall of 1996 emerged fairly well early in spring. The oriental ginseng did emerge this spring but very small plants. No noticeable visual differences were apparent between beds of ginseng given different fertility treatments. Yield data of biomass will be analyzed for further results.

The two 5-year old gardens in Carmangay and Brooks were harvested and has been shown that potential yields of 2000-3000 kg/ha of dried roots are possible in

Alberta. The results of disease observations are presented in the report of the plant pathology program.

Most of approximately 50 species of perennial medicinal plants established in 1996 and 1997 for adaptability evaluation, survived the winter. Valerian has been hit hard with aster yellow disease. Also the echinacea, especially *E. purpurea* has been affected by the aster yellow disease. Sclerotinia has been a problem in the *E. angustifolia*. Another 30 species of perennial and 18 annual medicinal plants were established in 1998 and biomass data was taken. The 1996 echinacea trials were completely harvested. Data has yet to be analyzed. Data was taken on plant population and direct field seeding vs transplanting trial with *E. angustifolia*. The *E. purpurea* trials became disease trials, they were hit by the aster yellow disease. Another direct seeding vs transplants of *E. angustifolia* was established in 1998. An observation trial of a selected few medicinal plants was also established. Plant biomass data and samples were taken and certain plants were distilled for essential oil.

Technology Transfer Services

Program staff continued to answer numerous inquiries on the production of special crops, particularly on herb, spice and essential oil crops. Information was contributed on special crops to producer newsletters and the news media, and the special crop varietal performance factsheet was updated. The program staff participated in courses, seminars and field tours. Demonstration plots of various special crops, including herbs, spices, essential oil, medicinal plants and other new crops, at Brooks and Bow Island were visited by a large number of interested individuals and groups. Extension staff and other interested parties were provided with planting materials for demonstration and field testing continued to help herb, essential oil and spice producers evaluate new crops and to develop their agronomic practices. The Alberta Regional Special Crops Varietal Test was coordinated, prepared and distributed. The performance data of registered varieties of fieldpeas, drybeans, lentils, fababeans and mustard was prepared and distributed to cooperators, specialists, growers and agribusinesses.

The program staff has been working with AVEC and supplied echinacea for dehydration trials. Also assisting with the essential oil project whenever possible with information and lending laboratory equipment. The special crops program at Brooks also provided large amounts of echinacea root to the Dept. of Agricultural, Food and Nutritional Science for extraction and analytical studies within the Nutraceutical Centre of Excellence at the University of Alberta.

Special Crops Program (Edmonton)

S.F. Blade and N. Clark

Alberta producers are interested in diversifying their production. This was especially true in 1998 as prices tumbled for several conventional crops. One successful strategy is to incorporate new crops into the farming system. The special crops program is dedicated to introducing new crops which will contribute to the long-term viability of agriculture in the province. Diversification can contribute to improving crop rotations through inclusion of pulse crops, reduce producers to price volatility in traditional crops and expand the opportunities for value-added processing in Alberta. The special crops program serves both large-scale conventional farmers and less-experienced entrepreneurs who wish to get involved in some of the more intensive production and processing opportunities presented by specific new crops.

The special crops program at CDCN has been active in the identification and development of economically-promising crops since 1995. The focus has been on several categories of new crops: pulses, spices, alternate crops, herbs (medicinal, culinary and aromatic) and fibre crops. Within the pulses, work with field peas holds the highest priority for the program. In addition to initiating a breeding program, the program works closely with other prairie breeding programs to ensure that producers can benefit from the rapid advancement of promising lines. The program also participates in the Western Canadian Forage Pea Network and the Western Canadian Field Pea Ascochyta Initiative.

Agronomic activities include large-scale field trials testing inoculant formulations and a collaborative trial testing field pea-barley silage cropping. The newest lentil, chickpea and faba bean lines are screened by the program. In 1998 assistance was provided in the testing of silage faba bean trials in north-central Alberta. Spice and alternate crop screening at several locations throughout Alberta identified potential candidates for further testing (caraway, coriander, borage, buckwheat). The herb screening at CDCN looked at 125 potential species (medicinal, culinary, aromatic) which were assessed under local conditions for adaptation. The special crops program has taken the lead in Alberta research on low-THC fibre hemp, which is evolving into a potential commercial crop due to the efforts of several Alberta collaborators.

The program is also represented on the AAFRD Special Crops Product Team, the Information Technology Committee and the Applied Research Strategy Group. The program was actively involved in both the Alberta Hemp Symposia and the "Opportunities and Profits: Special Crops into the 21st Century" conference. The special crops program would like to acknowledge the contribution of Eric Nfor, Teresa Hegg, Cynthia Watson and Meriem Benchabane for their assistance in 1998.

Research Projects

Field pea breeding and germaplasm evaluation

CDC Advance- To jumpstart the field pea breeding program, collaboration with the Crop Development Centre in Saskatoon allowed the program to obtain early-generation lines from crosses which were targeted to the cool, moist conditions of Alberta. Following original unreplicated screening in 1996, a replicated preliminary yield trial was conducted in Edmonton and Grande Prairie in 1997. The elite material was put into a multilocation yield test in several sites in both Saskatchewan and Alberta. The 1998 results identified three yellow cotyledon peas that outyielded the checks and which will be included in the 1999 Western Field Pea Cooperative conducted by the Prairie Registration Recommending Committee for Grain.

AAFRD/AAFC Breeding Agreement- In 1997 an agreement was signed between CDCN and the Agriculture and Agri-Food Canada Field Pea Breeding Program based in Morden, Manitoba. Approximately

1200 lines were tested in 1997, and the best 112 were tested in a preliminary yield trial at CDCN in 1998. It is anticipated that elite lines will be identified by multilocation testing in 1999, and placed into Cooperative testing in 2000.

CDCN- Crossing blocks were set up at CDCN, and F_1 and F_2 generations were advanced in 1998. This new material will be evaluated with several objectives in mind: plant maturity, height, harvestability, plant architecture, disease resistance, seed vigor and yield.

Intensive pea management

In collaboration with other sites in Alberta (Grande Prairie-Paul LaFlamme, St. Paul-Kirsty Piquette, Vermilion-Terry Buss, Camrose-Battle River Research Group) an agronomic trial was set up to evaluate the impact of four major management issues in the production of field pea. The four variables were seeding date, seeding rate, herbicide water volume and fungicide application. There was wide variation in how yield was affected by these factors, and this work will continue in 1999. Preliminary results from 1998 indicated that improper management resulted in severe reductions in yield which may explain why Alberta producers experience low yield stability for their field pea production.

Field pea inoculant trials

The third year of this experiment in collaboration with Dr. George Clayton (AAFC Lacombe) was conducted in 1998. The basis of the experiment was to determine the effects of inoculant formulations (liquid, peat powder, granular) with starter nitrogen (0, 20, 40 or 80 kg/ha of actual N) on nodulation, flat pod N content, final N content in grain and biomass and field pea grain yield adjacent to the 1997 sites at Vegreville and Calahoo. The previous years site was seeded to barley at each of the two sites. The barley was harvested at each of the two sites to investigate the effect of the previous years field pea inoculant/fertilizer treatments.

Field pea-barley silage trial

In 1998, in cooperation with Ken Lopetinsky and Zone #3 of the Alberta Pulse Growers, a field pea-barley silage trial was grown at CDCN and Barrhead. Fourteen field pea lines were grown in sole crop treatments, and intercropped with Seebe barley (1 bu/ac). Seven grain pea (Carrera, Integra, Carneval, Espace, Grande, Pekisko, Swing, Eiffel) and seven silage pea (Arvica, FP93074, MP1106, Packer, Performance 4010 Trapper and PC-12-89-335) lines were tested at either 0 or 60 kg/ha added nitrogen. Increased biomass and protein harvest were observed, and there were significant differences in biomass and protein and grain yield for fertility treatment, cultivar and location.

Pulse crop screening (lentil, faba bean, chickpea)

In collaboration with several seed companies and breeding programs, lentils lines were tested in Vermilion (in cooperation with Terry Buss), chickpea lines and faba bean (at CDCN). In collaboration with Randy Bjorklund the silage potential of ten faba bean lines was assessed by collecting data on biomass production and feed analysis.

Mycosphaerella blight trial

Ten field pea lines with varying degrees of resistance to mycosphaerella blight were planted in replicated trials at CDCN in 1998. The trials were rated for incidence and severity to determine whether there was potential for some of the material to be used in pyramiding genes for increased field pea resistance to the disease.

Special crops adaptation trials

In collaboration with Ken Lopetinsky several new crops in Namao and Barrhead were tested to assess their potential for the north-central region of Alberta. Data were collected on plant maturity, disease incidence, plant development and economic yield. An additional trial was planted at the AAFC station in Beaverlodge, with the assistance of Paul LaFlamme. An additional screening/demonstration trial was planted at CDCN.

Borage agronomy

Borage (*Borago officinalis*) is a new crop which has been grown on more acres in the past few years because it can be very productive in the Alberta environment. A first-year trial tested the effects of early and late-planting and fertility rate on seed production. A similar trial was planted in Grande Prairie by Paul LaFlamme.

Spice agronomy

The 1998 trials were the third year of a spice agronomy trial that incorporated the use of nurse crops for the production of biennial caraway. The use of coriander, field pea and Polish canola in the first year was evaluated on second and third year caraway seed yield.

Herb screening (medicinal, culinary, aromatic)

Approximately 150 species were started in the greenhouse and direct-seeded to conduct a preliminary screening process for a wide array of herbs that could have commercial potential in Alberta. The performance of several of the fourteen basil lines were impressive, and the program was able to provide large samples to the Agricultural Value-Added Engineering Centre for the their work on essential oil distillation. In addition, larger, replicated agronomic trials of ginseng (fifth year harvest) and echinacea (comparing densities and ridge vs flat cultivation) were also done. The perennial herbs were maintained to identify species that can overwinter. As a result of this overwintering study, St. Johnswort is one species that exhibits winter hardiness in this area.

Low-THC hemp research

In 1998 saw the continuation of the low-THC hemp research at two locations (black and dark brown soil zones). Cultivars from the Ukraine, Germany, France, Romania, Ukraine, Poland, Hungary and Finland were tested. A fertility trial was conducted looking at hemp response to nitrogen, phosphorus and potassium. The material was assessed for both fibre and seed yield at both locations. A very preliminary test was done at one location to evaluate the potential for low-THC hemp as a fodder crop.

Technology Transfer Services

Due to the high interest in this topic, program staff were called upon to answer numerous enquiries regarding a wide range of new crop opportunities relating to pulses, spices, medicinal plants and fibre crops. Staff contributed articles on crop diversification and species-specific topics to producer newsletters, industry periodicals and provincial newspapers. The interest in crop diversification resulted in several media interviews with newspaper, radio and television which were the source for further enquiries from the general public. Due to the great need for increased knowledge about these new crops, staff contributed to a large number of courses, seminars and field tours.

The Special Crops Field Day held at CDCN was a tremendous success, with more than 225 participants. Staff assisted members of the Pulse and Special Crops Team by assisting with securing planting materials for demonstrations across the province, and sourcing technical information which was then extended to clients. A new innovation was involvement in Ask The Expert and Agri-Ville electronic forums provided an opportunity for staff to interact directly with producers in a new and highly effective forum. Clients included producers, other AAFRD Units, universities, Agriculture and Agri-Food Canada, other provincial agriculture departments, applied research associations and agri-industry. An interesting component of the work was that many of the trials were done as researcher-managed on-farm experiments, which allowed neighbors to view technological innovations in their own area.

Special Crops Program (Lacombe)

R. Park

The special crops program at the Field Crop Development Centre, Lacombe, is responsible for special crops technology transfer and for partnering with associated government and private sector groups for the advancement of the special crops industry in Alberta. The program also participates in a small agronomy and varietal assessment program, concentrated primarily on grain legumes. In 1998, applied research projects were conducted at four sites in north central Alberta.

Research Projects

Field pea individual seed growth rate test (ISGR)

This test was established to study the effect of controlled flower abortion on pea with the possibility of proving that the loss of flowers on pea plants during full bloom may result in increased seed size. Alberta field pea producers rely almost exclusively on imported European varieties for commercial production. As a rule, the seed size of these imported cultivars has increased during pedigreed multiplication, thus discouraging pea production, in some cases, as well as increasing planting costs. The study showed the same encouraging results in 1998 as it did in 1997. The project now has four station years of data and will be continued for another year to try and add four additional station years to the existing data.

Technology Transfer Services

The program leader continued to receive and answer many inquiries on varieties, production and marketing of various special crops. Articles were written for producer newsletters, magazines and for the news media. Participated in numerous courses, seminars and field tours, and provided AAFRD Pulse and Special Crops Specialists with information as requested. The leader also participated in the formal training of these Specialists. The leader was active in the organization and coordinating of AAFRD Pulse and Special Crop Specialists for a major Pulse Production Guide writing assignment. Also wrote one section of the Guide and assisted with the writing of one other. Besides major editor for the Guide, was charged with the responsibility of working with Publications Branch, Communication Division to get the publication process started in 1998. The Alberta Pulse Production Guide will be available to producers and industry during the second quarter of 1999. The program leader continued to partner with AAFRD Pulse and Special Crops Specialist Ken Lopetinsky in publishing the results of the 1994-97 Green Pea Bleach Test study. In association with industry partner Zeneca, more than 35,000 copies of the published results have been distributed as an Agri-Fax Publication.

Weed Science Program

R. Esau and B. Kruger

The major emphasis of this program is to develop new weed control systems and improve existing ones for vegetable, potato, fruit, nursery, pulse and special crops. Commercial and experimental herbicides, as well as different crop management techniques, are evaluated to accomplish this objective. A second objective is to determine safe recropping intervals for potato and special crops following the use of soil-persistent herbicides. Weed control information is provided to commercial growers by phone, farm visits and workshops.

Research Projects

Weed control in vegetable crops

Onion - This crop is a weak competitor against weeds and requires a preemergent or early postemergent herbicide with good residual activity. Pendimethalin (Prowl) meets this requirement partially in that it has residual activity. A trial was conducted to broaden the weed control spectrum for pendimethalin by testing several tank mixes including oxyfluorfen (Goal) and bromoxynil (Pardner). These mixtures were applied at either the flag or one-leaf stage of onion; certain treatments were followed by linuron (Lorox) and sethoxydim (Poast) at the two-leaf stage. Tarmagon and Norstar onion yields were significantly reduced by all of the herbicide treatments in comparison to the hand-weeded check. It appears that a herbicide program for onion will have to be supplemented with cultivation.

Squash - As in 1997, a micro-encapsulated formulation of clomazone (Merit) was tested in acorn and zucchini squash. In addition, the registered herbicide napropamide at 1.1 and 2.2 kg ai/ha, applied preemergence, was also included in this trial for comparison to clomazone. Leaves of acorn and zucchini squash were partially whitened by clomazone treatments, but these symptoms were soon outgrown. In a crop tolerance trial (all weeds were manually removed), zucchini total crop yields were unaffected by clomazone and napropamide and significantly reduced by bentazon (Basagran). Similarly, yields for acorn squash treated with these herbicides were either equal to or significantly greater than the untreated check. In another trial, weeds were manually removed only from the hand-weeded check. Under these conditions, acorn squash yields were significantly reduced for clomazone (0.28, 0.56 and 0.84 kg ai/ha), napropamide and bentazon in relation to the hand-weeded check. Clomazone treatments failed to control redroot pigweed and napropamide did not adequately control hairy nightshade, redroot pigweed, volunteer barley, mustard and common lamb's-quarters.

Weed Control in Potato

Work with potatoes was focussed mainly on combinations with rimsulfuron (Prism) to broaden the spectrum of weeds controlled. Rimsulfuron and rimsulfuron + metribuzin (Sencor/Lexone) treatments yielded lower marketable potato yield (Shepody and Russet Burbank) than the weed-free check, however, yields for pendimethalin (Prowl) + rimsulfuron and linuron (Lorox/Afolan) + rimsulfuron treatments were not reduced. Rimsulfuron and rimsulfuron + metribuzin suppressed hairy nightshade, but there appeared to be sufficient weed competition to affect crop yields. The outstanding treatment was a combination of linuron + pendimethalin applied pre-emergence (ground crack).

Herbicide carryover

Odyssey (1:1 mixture of imazamox and imazethapyr) at 30 g ai/ha, imazamox (AC 299,263) at 20 g ai/ha and imazethapyr (Pursuit) at 50 g ai/ha were applied to peas in 1996, 1997 and in 1998. The plots treated in 1996 were seeded to canola and flax in 1998; the 1997 site was seeded to canola, flax and potato. None of the three herbicides applied in 1996 affeced canola and flax. Initial crop injury to canola, flax and potato was noted at the site treated in 1997, however biomass (based on dry weight) and potato total and marketable yields were unaffected. Canola fresh weight biomass was significantly reduced by imazethapyr. The 1998 site will be recropped in 1999.

Clomazone (Merit) plots which had been treated in 1997 at rates of 0.28, 0.56 and 0.84 kg ai/ha were reseeded to wheat in 1998. Temporary whitening of some wheat plants was noted at the highest rate, but these symptoms were outgrown after three weeks. Wheat seed yield was unaffected by clomazone applied the previous season. Similarly, plots treated with rimsulfuron (Prism) in 1997 were reseeded to sugar beet and canola. These two crops were set back by the carryover from rimsulfuron herbicide, however at harvest time, biomass was unaffected.

Weed control in special crops

Pulse Crops - Four bean types (pinto, red kidney, pink and great northern) were evaluated for tolerance to Odyssey applied at 0, 30 and 60 g ai/ha with Merge adjuvant at 0.5% (v/v) when the crop was in the first trifoliate leaf stage. All bean types were temporarily chlorotic after Odyssey application. Both rates of Odyssey depressed bean yields, the lower rate more significantly than the 2X rate. These reduced yields are attributed to weed competition from lamb's-quarters, a weed which is not adequately controlled by this product. Odyssey controlled redroot pigweed, hairy nightshade and mustard.

Desi Chickpea - Weed control studies were initiated for desi chickpea in view of this crop's potential for the Dark Brown and Brown soil zones of the prairie region. Ethalfluralin was applied to the entire plot area to evaluate post-emergent treatments of metribuzin (Sencor) and clethodim (Select). Chickpea was severely injured by metribuzin (Sencor) at 0.28 kg ai/ha applied postemergence to the crop. Control of weeds by metribuzin applied pre-emergence and pre-plant incorporated was inferior to postemergence applications. The trial was severely infested with hariy nightshade, a weed that is not controlled by metribuzin. The chickpeas were subsequently overrun with this weed so that no crop yields were obtained. Clethodim (Select) at the X and 2X rates had no effect on chickpea. During 1998, Sencor and Select were approved for use in chickpea by the minor use program.

Canary seed - Quinclorac (Accord) was applied at 100, 125 and 200 g ai/ha to control green foxtail. In addition, the lowest rate of quinclorac was evaluated in combination with difenzoquat (Avenge) and bromoxynil + MCPA (Buctril M). A combination of quinclorac + difenzoquat + bromoxynil + MCPA and fenoxaprop-p-ethyl (Puma) were also tested. The latter treatment caused significant crop injury, but injury for the other treatments was minimal. Seed yields were not affected. Quinclorac at all rates and fenoxaprop provided excellent control of green foxtail.

Weed control in forage seed crops

The control of wild oat is one of the major constraints for the production of perennial ryegrass seed. Puma and Assert herbicide were evaluated at the common use rate (X) and 2X rates; both products were also tested in tank mixtures with 2,4-D ester. Crop injury linked to the application of Puma was within acceptable limits and seed yields were unaffected. Assert, however, at either rate caused unacceptable injury and seed yields were reduced in relation to the weed-free check. Assert mixed with 2,4-D produced very similar results to that for Assert alone. In another trial, perennial ryegrass seed production was unaffected by applications of Buctril M, 2,4-D ester, Banvel, and Attain (X and 2X rates). An additional area was seeded to perennial

ryegrass in late August to re-evaluate the treatments in 1999.

Two trials with Kentucky bluegrass were conducted in 1998. In one trial, 18 herbicide treatments were applied last year when the crop was in two-leaf stage. Plots treated with bromoxynil + MCPA (Buctril M) at 0.56 and 1.12 kg ai/ha and diclorprop+2,4-D ester (Estaprop) at 1.02 and 2.04 kg ai/ha provided significantly higher seed yields than the weedy check. Seed yields for other herbicide treatments tested were unaffected compared to the weedy check. In a second trial, 18 herbicide treatments were applied to an established stand of Kentucky bluegrass for the control of broad-leaved weeds. No significant crop injury was noted for any of the treatments and seed yields were not significantly affected by any of the treatments in relation to the hand-weeded check.

Weed control in fruit crops

The objective of a weed control trial was to evaluate a combination of trifluralin (Treflan) plus metribuzin (Sencor) tank mix, applied pre-plant incorporated, for broad-spectrum weed control in saskatoon. This mixture is registered for use in saskatoon planted for shelterbelts with a restriction that it be used on soils with 5% organic matter or higher. The test site at Brooks had an organic matter content of approximately 2.0%. Saskatoon tolerance to trifluralin is excellent, however the tolerance to metribuzin was unknown. Preplant incorporated treatments of metribuzin at 0.28 and 0.4 kg ai/ha in a tank mixture with trifluralin and metribuzin at 0.28 kg ai/ha alone were compared to a hand weeded check. Severe phtytoxicity was observed on 'Thiessen' saskatoon seedlings which had been transplanted into soil with metribuzin treatments. The saskatoon seedlings had been grown in "Rootrainers" and were equivalent to a one-year-old seedling. Survival overall of Saskatoon seedlings was unaffected but will be reevaluated in 1999.

Technology Transfer Services

Weed control recommendations were provided to growers by telephone, letter or office/farm visits, and presentations were made at producer and professional meetings. This Program participated in a perennial ryegrass tour. Several informal tours of the research plots were conducted for interested growers and technical representatives of chemical companies. The Weed Science Program continued to receive a significant number of enquiries concerning safe recropping intervals following the use of persistent herbicides for potato and vegetable crops . The Program Leader served as a member of the Special Crops Product Team and as acting chairman for the Alberta Weed Advisory Committee.

Publications and Presentations

Abstracts

Blade, S.F. 1998. Field pea production in Alberta: success of a "new" crop. Canadian Society of Agronomy annual meeting (Vancouver, B.C.) abstract. Can. J. Plant. Sci. (In press).

Blade, S.F. 1998. Low-THC hemp production in Alberta. Canadian Society of Agronomy annual meeting (Vancouver, B.C.) abstract. Can. J. Plant. Sci. (In press).

Blade, S.F. 1998. Medicinal plant production: managing the "phyto-factory". Canadian Botanical Association, Saskatoon, SK. Canadian Botanical Association 98:28.

Blade, S.F. 1998. On-farm low-THC hemp research in Alberta. Commercial Hemp, Winter Edition, 1998.

Blade, S.F., R. Gaudiel and N. Kerr. 1998. Evaluation of low-THC hemp (*Cannabis sativa*) in the black and dark brown soil zones of Alberta, Canada. New Crops and New Uses, Association for the Advancement of Industrial Crops (Phoenix, Arizona) abstract. November 11-13.

Chang, K.F., S.F. Hwang, R.J. Howard, P. Ragan, L.M. Dosdall and B. Choban. 1998. Cultural and chemical control of fungal root rots and root maggots in cole crops. Proc. 7th Int. Cong. Plant Pathol., Edinburgh, Scotland, Volume 3: 6.21.

Hwang, S.F., K.F. Chang, R.J. Howard and G.D. Turnbull. 1998. Effect of seed damage and fungicide seed treatments on seedling emergence and yield of field pea. Proc. 7th Int. Cong. Plant Pathol., Edinburgh, Scotland, Volume 3: 6.23.

Wang, H., K.F. Chang, S.F. Hwang, G.D. Turnbull and R.J. Howard. 1998. Efficacy of fungicides against Sclerotinia disease of Echinacea. Phytopathology 88: S94.

Wang, H., K.F. Chang, S.F. Hwang, G.D. Turnbull and R.J. Howard. 1998. Effect of inoculation, incubation and temperature on sclerotinia blight of purple coneflower. Can. J. Plant Pathol. (Accepted).

Research Reports

Bains, P.S. and M. Mirza. 1998. Powdery Mildew of Tomato: Fungicidal Control and Some Aspects of Biology of the Pathogen. AARI Project #97M078. 21 pp.

Bains, P.S. and C.A. Schaupmeyer. 1998. Field evaluation of difenoconazole and fludioxonil as seed tuber treatment in controlling Rhizoctonia disease of potato (*Rhizoctonia solani*). Submitted to Novartis Crop Protection.

Blade, S.F., K. Lopetinsky and R. Mueller. 1998. Evaluation of silage pea cultivars for biomass and grain yield. AARI Project report #97-NW-02.

Blade, S.F., T.J. Buss, P. LaFlamme, K. Piquette and A. Eyolfson. 1998. Intensive field pea management. Pulse Crops Research Group Volume 3:45.

Blade, S.F., J. Kloberdanz and C. Weeks. 1998. Low-THC hemp research in the dark brown soil zone. AARI-OFD Research Report.

Calpas, J., P. Coté and S. Graham. 1998. Greenhouse sweet pepper cultivar trial. Greenhouse Coverings 98-3, p. 4.

Calpas, J., P. Coté and S. Graham. 1998. Preliminary evaluation of "Ballistic", a natural food grade foliar feed product and "Kelp Blend", a natural seed treatment, on the yield of a Southern Alberta fall greenhouse cucumber crop. Greenhouse Coverings 98-3, p. 5.

Calpas, J., P. Coté and S. Graham. 1998. Greenhouse fall crop cucumber cultivar trial. Greenhouse Coverings 98-4, p. 5.

Calpas, J., P. Coté and S. Graham. 1998. Evaluation of two commercial clay products on the production of a southern Alberta spring greenhouse cucumber crop. Greenhouse Coverings 98-4, p. 6.

Calpas, J., P. Coté and S. Graham. 1998. Preliminary investigation into the potential of greenhouse scotch bonnet pepper production. Greenhouse Coverings 98-4, p. 7.

Chang, K.F., R.J. Howard, W. Van Roessel and H. Fenske. 1998. Demonstration of chemical control and cultivar resistance for reducing halo blight of dry bean. FFF Project #98SR03, Progress Report. 29 pp.

Choban, B.J. 1998. 1998 Vegetable Trials, CDCN Pamphlet #98-V08.

Hausher, L.G. and S. Dalpé. 1998. 1998 Fruit Crops Trials. CDCS Pamphlet 99-6.

Howard, R.J., Y.A. Lecuc and S.P. Huggons. 1998. Efficacy of seed treatments for the control of halo blight and common blight on dry edible beans in field trials at Exeter, ON.

Howard, R.J., Y.A. Lecuc and S.P. Huggons. 1998. Efficacy of seed treatments for the control of halo blight and common blight on dry edible beans in field trials at Morden, MB.

Howard, R.J., Y.A. Lecuc and S.P. Huggons. 1998. Efficacy of seed treatments for the control of halo blight and common blight on dry edible beans in field trials at Outlook, SK.

Howard, R.J., Y.A. Lecuc and S.P. Huggons. 1998. Efficacy of seed treatments for the control of halo blight and common blight on dry edible beans in field trials at Saskatoon, SK.

Hwang, S.F., G.D. Turnbull, B. Gossen, K.F. Chang and R.J. Howard. 1998. Control strategies for fusarium root rot of lentil. FFF Project #94M645, Final Report. 87 pp.

McKenzie, R.C., R.H. McKenzie and L. Kryzanowski. 1998. Fertilizer requirement of irrigated alfalfa. Alta. Agric. Res. Inst. Final Report for Project 94M626, 60 pp. March.

McKenzie, R.C. and S.A.Woods. 1998. Precision farming with potatoes. Alta. Agric. Res. Inst. Progress Report for Project 96M979, 13 pp. February.

Mirza, M. and M. Younus, Y. Hoyano and R.A.Currie. 1998. Greenhouse Production of Echinacea and Other Medicinal Plants. *In* Proceedings. Opportunities and Profits II: Special Crops in the 21st Century, Edmonton, AB, November 1-3.

Murray, C.L. and R.C. McKenzie. 1998. Investigation of controlled-release fertilizer for container-grown woody plants in Alberta. AARI #96M961- Final report. June.

Murray, C.L., T.T. Pheh and N.G. Seymour. 1998 Nursery Crops Program. CDCS Pamphlet 98-8.

Najda, H.G. and A. Kruger. 1998. Field Crops Cultural and Cultivar Trials 1997. CDCS Pamphlet 98-9. Alberta Agriculture, Food and Rural Development. 116 pp.

Panford, J.A. 1998. Determination of Carotenes and Xanthophylls in Alberta-Grown Vegetables. Alberta Agriculture Research Institute and Gimbel Eye Centre, Calgary, AARI Matching Grants Program Project #96M943 Final Report.

Panford, J.A., J. Holley, P. Ragan and M. Fierheller. 1998. Use of Modified Atmosphere Packaging Technology in Retail Packaged Fresh Precut Vegetables. Alberta Agriculture Research Institute and the former Alberta Fresh Vegetables Marketing Board, AARI Matching Grants Program Project #95M706 Final Report.

Ragan, P. and W. Johnson. 1998. Vegetable Variety Adaptation Trials, CDCS Pamphlet 99-5.

Ragan, P. and W. Johnson. 1998. Vegetable Production Trials, CDCS Pamphlet 99-4.

In 1998 Pest Management Research Report - Insects and Plant Diseases. Expert Committee on Integrated Pest Management, Agriculture and Agri-Food Canada. ON. January, 1999.

Chang, K.F., M.A. Briant, S.M. Sims, R.J. Howard, J.A. Motta and K.W. Pruski. 1998. Efficacy of two insecticides against silvertop on two cultivars of Kentucky bluegrass at Brooks, AB. p. 136-141.

Chang, K.F., R.J. Howard, M.A. Briant and S.F. Hwang. 1998. Efficacy of fungicides for the control of botrytis blight on chickpea at Brooks, AB. p. 204-205.

Chang, K.F., R.J. Howard, M.A. Briant, S.F. Hwang, G.D. Turnbull and H. Wang. 1998. Comparison of two Apron formulations for the control of root rot diseases of field pea. p. 272-273.

Chang, K.F., R.J. Howard, M.A. Briant and W. Van Roessel. 1998. Seed treatment and foliar application with Kocide LF to control halo blight of dry bean at Bow Island, AB. p. 209-210.

Chang, K.F., R.J. Howard, S.F. Hwang, G.D. Turnbull and H. Wang. 1998. Assessment of fungicidal seed treatments for the control of mycosphaerella blight of field pea. p. 274-275.

Howard, R.J., Y.A. Leduc, S.P. Huggons and M.A. Briant. 1998. Efficacy of chemical seed treatments against seed-borne bacterial blight in dry beans in greenhouse trials at Brooks, AB. p. 211-218.

Howard, R.J., Y.A. Leduc, S.P. Huggons, M.A. Briant, S.M. Sims and C.L. Bandura. 1998. Efficacy of seed treatments for the control of halo blight and common blight on dry edible beans in field trials at Brooks, AB. p. 136-141.

Hwang, S.F., G.D. Turnbull, K.F. Chang and R.J. Howard. 1998. Evaluation of Crown and Vitaflo 280 to control Fusarium root rot of ascochyta-resistant lentil cultivars. p. 285-286.

Hwang, S.F., G.D. Turnbull, K.F. Chang and R.J. Howard. 1998. Evaluation of Bravo foliar spray formulations for the control of mycosphaerella blight of field pea. p. 276-278.

Turnbull, G.D., S.F. Hwang, K.F. Chang and R.J. Howard. 1998. Evaluation of foliar fungicides for the control of mycosphaerella blight of field pea at Vegreville, AB. p. 281-282.

Wang, H., S.F. Hwang, G.D. Turnbull, K.F. Chang and R.J. Howard. 1998. Evaluation of Maxim and Apron XL as seed treatments for the control of fusarium root rot of chickpea. p. 206-208.

Wang, H., S.F. Hwang, G.D. Turnbull, K.F. Chang and R.J. Howard. 1998. Evaluation of Maxim and Apron XL as seed treatments for the control of fusarium root rot of lentil. p. 287-288.

Scientific Papers

Bains, P.S., V.S. Bisht, D.R. Lynch, L.M. Kawchuk and J.P Helgeson. 1998. Identification of stem rot (*Erwinia carotovora* subspecies *atroseptica*) resistance in potato. American Journal of Potato Research. (Accepted).

Chang, K.F., R.J. Howard, R.G. Gaudiel, S.F. Hwang and S.F. Blade. 1998. Diseases of ginseng in Alberta in 1997. Can. Plant Dis. Surv. 78:89-91.

Chang, K.F., R.J. Howard, S.F. Hwang, R.G. Gaudiel and S.F. Blade. 1998. Diseases of echinacea in Alberta in 1997. Can. Plant Dis. Surv. 78:95-97.

Hwang, S.F., K.F. Chang, R.J. Howard and L.M. Kawchuk. 1998. First report of a yellows disease of evening primrose (*Oenothera biennis* L.) and curled chervil (*Anthriscus cerefolium* (L.) Hoffm.). J. Plant Dis. Prot. 105: 64-70.

Lange, R.M., P.S. Bains and R.J. Howard. 1998. Efficacy of fungicides for control of entomosporium leaf and berry spot of saskatoon. Plant Dis. 82: 1137-1141.

Selected Reports

P. Bains, G. Gillund, C. King, F. Kraft and C. Moroziuk. 1998. A proposed Framework for Leadership in Environmental Sustainability. Submitted to Executive Committee by Environmental Strategy Development.

Chang, K.F., R.J. Howard, S.F. Hwang, R.G. Gaudiel and S.F. Blade. 1998. Disease occurrence and management practices in ginseng gardens in Alberta. 7 pp., Alberta Ginseng Association Annual Meeting, Red Deer, AB. April 18.

Chang, K.F., R.J. Howard, S.F. Hwang, R.G. Gaudiel and S.F. Blade. 1998. Diseases in medicinal and aromatic plants. *In* Proceedings of the Prairie Medicinal & Aromatic Plants Conference 1998. pp. 33-39, Saskatoon, SK. March 5-7.

Najda, H.G. and A. Kruger. 1998. Report on industry sponsored irrigated grass seed variety trials. AARI Project #98E216. 50 pp.

Presentations at Professional Meetings and Scientific Conferences

Bains, P.S. and C.A. Schaupmeyer. 1998. Rhizoctonia disease of potato (*Rhizoctonia solani*): fungicidal control, susceptibility of potato cultivars and advanced breeding lines and infection of rotation crop plants with the pathogen. *In* the 7th International Congress of Plant Pathology, Edinburgh, Scotland, August 9-16.

Blade, S.F. 1998. Is there hope for hemp? The Canadian experience. Keynote address, North American Industrial Hemp Conference, Washington, D.C., November 8-11.

Blade, S.F. (Editor). 1998. The Alberta Hemp Symposia Proceedings. Alberta Agriculture, Food and Rural Development, Edmonton, AB, 87 pages.

Blade, S.F. 1998. Industrial hemp production in Alberta. *In* The Alberta Hemp Symposium Proceedings. Alberta Agriculture, Food and Rural Development, Edmonton, AB, pp. 2-20.

Calpas, J. 1998. Greenhouse pepper production in Alberta. University of Alberta, Agriculture, Food and Nutritional Science, AFNS 601 Seminar, February.

Calpas, J. 1998. Update of greenhouse crops research at the Crop Diversification Centre South. Alberta Horticultural Congress, Edmonton, AB, November 12.

Chang, K.F. 1998. Current agriculture status of Alberta and biological control of plant diseases. Institute of Applied Microbiology, Heilongjiang Academy of Sciences, Harbin, China, September 11.

Chang, K.F. 1998. Diseases of specialty and vegetable crops and their control measures. Tianjin Institute of Plant Protection, China, September 17.

Chang, K.F. 1998. Biological control of Pythium root rot of cucumber and tomato under greenhouse conditions. Laiyang Agricultural College, Shandong, China, September 20.

Chang, K.F., S.F. Hwang, R.J. Howard, P. Ragan, L.M. Dosdall and B. Choban. 1998. Cultural and chemical control of fungal root rots and root maggots in cole crops. *In* The 7th International Congress of Plant Pathology, Edinburgh, Scotland, August 9-16.

Feddes-Calpas, J. 1998. Dutch Elm Disease Presentations. Agriculture Service Board Regional Meetings, Devon, Oct. 29, Claresholm, Oct. 30 and Cochrane, Nov. 5.

Hingley, L.E., S.A. Woods and R.C. McKenzie. 1998. How technologies can identify soil salinity and determine tolerances of sensitive crops. Presented at Alberta Agron Workshop and Alberta Soil Science Workshop. Edmonton, AB, February.

Hwang, S.F., K.F. Chang, R.J. Howard and G.D. Turnbull. 1998. Effect of seed damage and fungicide seed treatments on seedling emergence and yield of field pea. *In* the 7th International Congress of Plant Pathology, Edinburgh, Scotland, August 9-16.

Hwang, S.F., G.D. Turnbull, K.F. Chang and R.J. Howard. 1998. Attention to pea seed quality could boost seedling establishment. Special Crops Conference, Edmonton, AB, November 1-3.

McKenzie, R.C. and S.A. Woods. 1998. Precision farming with potatoes at Alberta Soil Science Workshop. 13 pp. Edmonton, AB, February.

McKenzie, R.C., S.A. Woods, R.H. McKenzie and L. Kryzanowski. 1998. Fertilizer requirement of irrigated alfalfa. A poster presentation at the North American Alfalfa Improvement Congress. Bozeman, Montana, August 3.

McKenzie, R.C. 1998. Crop losses due to hidden salinity. *In* Trails to 2000. Proceedings of AB Agric. Res. Inst. Conf. 12 pp. Medicine Hat, AB, March.

Mirza, M. and M. Younus. 1998. Greenhouse Production of Medicinal Plants. Canadian Herb Society 3rd Annual Herb Growers Conference. Burnaby, BC, February 6-7.

Mirza, M. 1998. Managing Tomato Crops in Greenhouses. Mississippi Greenhouse Growers Association Annual Meeting. Jackson, Mississippi, USA, March 12-14.

Mirza, M. 1998. Production of Greenhouse Tomatoes and Cucumbers. Southern Greenhouse Growers Association Annual Meeting. Tyler, Texas, USA, July 16-18.

Mirza, M. 1998. Greenhouse Industry in Alberta. Crops Diversification Workshop. Rocky Mountain House, AB, January 29.

Mirza, M. 1998. Reading a Tree Seedling and Making Decisions. Forest Nursery Technology & Silviculture Practices, Module VII. Edmonton, AB, October 22-23.

Mirza, M. 1998. Diagnosing Problems in Greenhouse Ornamentals. Hort. Congress. Edmonton, AB. November 12-14.

Park, R. 1998. Pulse crop production information. Pulse and Special Crop Specialists, Specialist Training, Edmonton, AB, June, September & October.

Park, R. 1998. Organizing and presenting material. Pea Optimum Productivity Meeting, Edmonton, AB, May.

Wang, H., K.F. Chang, S.F. Hwang, G.D. Turnbull and R.J. Howard. 1998. Efficacy of fungicides against Sclerotinia disease of Echinacea. *In* American Phytopathological Society Annual Meeting, Las Vegas, November 8-12.

Wang, H., S.F. Hwang, G.D. Turnbull, K.F. Chang and R.J. Howard. 1998. Effect of inoculation, incubation and temperature on sclerotinia blight of purple coneflower. PPSA Annual Meeting, Lloydminster, AB, November 2-4.

Presentations at Grower and Agri-Business Meetings and Courses

Bains, P.S. 1998. Diseases of saskatoon and their control. Saskatoon Berry Production Workshop, Saskatoon, SK, November 20-21.

Bains, P.S. 1998. Contamination of cultures in micropropagation systems. Workshop, Contamination and Procedures of Plant Tissue Cultures. Edmonton, AB, February 18-19.

Bains, P.S. 1998. Saskatoon disease research updates and future directions. Alberta Horticulture Congress, . Edmonton, AB, November 12-14.

Bains, P.S. 1998. Control of saskatoon diseases. FGSA, Annual Meeting, Camrose, AB, July 5.

Blade, S.F. 1998. Alberta Field Pea Research Network priority research needs. Lacombe, AB, January 20.

Blade, S.F. 1998. Performance of low-THC hemp in Alberta. Health Canada Hemp Stakeholders Meeting, Ottawa, ON, January 26.

Blade, S.F. 1998. Field pea cultivar development. Fields of the Future (AgriFutures), Red Deer, AB, February 6.

Blade, S.F. 1998. New Crop Development in Alberta. Agronomy Update, Edmonton, AB, February 10.

Blade, S.F. 1998. New pea cultivars for 1998. Leading Edge Seminar, Westlock, AB, February 26.

Blade, S.F. 1998. New information on Alberta hemp field research. Alberta Hemp Research Network, Olds, AB, March 2.

Blade, S.F. 1998. Potential for field pea in south-central Alberta. Coronation District Office, March 3.

Blade, S.F. 1998. Medicinal and aromatic plants research: Alberta update. Prairie Medicinal and Aromatic Plants Conference, Saskatoon, SK, Mar 4-6.

Blade, S.F. 1998. New crops for Alberta. Devonian Botanical Garden, Devon, AB, March 14.

Blade, S.F. 1998. Field pea research in Alberta. St. Paul, March 18.

Blade, S.F. 1998. Low-THC hemp research update. Saskatoon/Prince Albert, SK, April 2-3.

Blade, S.F. 1998. New Crops in Alberta. Ukrainian Cultural Village, Vegreville, AB, April 5.

Blade, S.F. 1998. How can Alberta diversify? Rotary Farmers Banquet, Big Valley, AB, April 6.

Blade, S.F. 1998. Looking for new diversification opportunities? Peace Innovation Centre, Dawson Creek, B.C. April 17.

Blade, S.F. 1998. How can Alberta diversify its cropping systems? Thorhild Ag. Society, Thorhild, AB, April 24.

Blade, S.F. 1998. Industrial hemp production in Alberta. Alberta Hemp Symposium, Red Deer-March 10, Edmonton-April 8.

Blade, S.F. 1998. Medicinal plant production. Flower and Herb Growers Association of Alberta Annual Meeting, Edmonton, AB, May 2.

Blade, S.F. 1998. New crops on the horizon. Canadian Crop Insurance General Managers Annual Meeting, Banff, AB, July 16.

Blade, S.F. 1998. Agronomics of feed peas. Pulse Crop Field Day, Holmstrom Seed Farm, Killam, AB, Jul 21.

Blade, S.F. 1998. CDCN-Special Crops Field Day, July 30.

Blade, S.F. 1998. New crops. Lakeland Agricultural Research Association field day, Fort Kent, AB, Aug 8.

Blade, S.F. 1998. Alberta hemp research. CGP Hemp Conference, Winnipeg, MB, August 13.

Blade, S.F. 1998. How can Alberta diversify? Sangudo Ag. Society, Sangudo, AB, Oct. 15.

Blade S.F. 1998. New crops, new products. Food processing graduate studies class, University of Alberta, Oct 26

Blade, S.F. and D. Macyk. 1998. The role of Plant Industry Division in agricultural research. University of Alberta/AAFRD research meeting. December 23.

Calpas, J. 1998. Greenhouse vegetable crop production. Olds College Horticulture student seminar. CDCS, Brooks, AB, August 13.

Calpas, J. 1998. Greenhouse research. Olds College Applied Degree student seminar. CDCS, Brooks, AB, October 28.

Calpas, J. 1998. Applied greenhouse crop research. University of Calgary student seminar. CDCS, Brooks, AB, October.

Chang, K.F., R.J. Howard, S.F. Hwang, R.G. Gaudiel and S.F. Blade. 1998. Disease occurrence and management practices in ginseng gardens in Alberta. Alberta Ginseng Association Annual Meeting, Red Deer, AB, April 18.

Chang, K.F., R.J. Howard, S.F. Hwang, R.G. Gaudiel and S.F. Blade. 1998. Diseases in medicinal and aromatic plants. Prairie Medicinal & Aromatic Plants Conference 1998, Saskatoon, SK, March 5-7.

Choban, B.J. 1998. Post harvest pre-cooling and storage of fresh vegetables. Edmonton and Lethbridge, AB, February.

Choban, B.J. 1998. Rhubarb production. Alberta Fruit Growers Association Berry School, Edmonton, AB, March.

Choban, B.J. 1998 Growers diversification into vegetable crops. Vegreville Ag. Society, Vegreville, AB, April.

Choban, B.J. 1998. Vegetable production. Ag. Service Board, CDCN, Edmonton, AB, July.

Choban, B.J. 1998. Vegetable trials. CDCN Special Crops Field Day Tour, Edmonton, AB, July.

Choban, B.J. 1998. Vegetable crops. Lakeland Agricultural Research Association Field Day, Fort Kent, AB, August.

Choban, B.J. 1998. Market gardeners' toolbox. Alberta Horticultural Congress, Edmonton, AB. November.

Choban, B.J. 1998. Vegetable growers' production workshop. Edmonton, Innisfail and Lethbridge, AB. December.

Duplessis, P.M. 1998. Gibberellic acid - viagra for potatoes? Potato Growers of Alberta Annual Meeting. Banff, AB, November 18.

Feddes-Calpas, J. 1998. Alberta DED Program Update. Saskatchewan DED Association Meeting. Estevan, SK. June 23.

Feddes-Calpas, J. 1998. Dutch Elm Diseas. Federal Custom Officials. Caraway, Coutts and Chief Mountain Port-of-Entries. Jun 9- 10.

Feddes-Calpas, J. 1998. DEDI Update. Society to Prevent Dutch Elm Disease (STOPDED) Meetings, Calgary, AB, January 21; Medicine Hat, AB, April 15; Red Deer, AB, June 17; Sherwood Park, AB, Oct. 28.

Feddes-Calpas, J. 1998. Agronomy Update-1998 Conference. STOPDED Booth, Edmonton, AB, January 15.

Feddes-Calpas, J. 1998.International Society of Arborists (ISA) Conference Trade Show. STOPDED Booth, Winnipeg, MB, September 23-26.

Feddes-Calpas, J. 1998. Prairie West Horticulture Trade Show. Dutch Elm Disease and Purple Loose Strife Booth, Edmonton, AB, November 12-13.

Feddes-Calpas, J. 1998. Agriculture Service Board Regional Trade Shows. Dutch Elm Disease Booth, Vermilion, Oct.26, Devon, Oct. 29, Claresholm, Oct. 30 and Cochrane, November 5.

Feddes-Calpas, J. 1998. DED Prevention Workshop, Taber, AB, April 23.

Feddes-Calpas, J. 1998. DED Prevention Workshop. Castor, AB, December 3.

Hausher, L.G. 1998. Fertility needs of Alberta fruit crops. Fertility Workshop, Edmonton, AB, January.

Hausher, L.G. 1998. Strawberry/raspberry/ saskatoon production and marketing topics. Commercial Berry Production School. Edmonton, AB, February.

Hausher, L.G. 1998. Prairie (strawberry) production systems. North American Growers Association Annual Meeting, Victoria, BC, February.

Hausher, L.G. 1998. Establishing a saskatoon berry orchard. Saskatoon/Chokecherry Production Workshop, Edmonton, AB, March.

Hausher, L.G. 1998. Alberta fruit crop research and technology transfer program. Fruit Crops Program Review, Airdrie, AB, March.

Hausher, L.G. 1998. Home grown innovations. Alberta Horticultural Congress, Edmonton, AB, November.

Hausher, L.G. 1998. Fruit crop weed and pest control. Seven Star Growers Workshop, Lethbridge, AB, March.

McKenzie, R.C. and S.A. Woods. 1998. Precision farming with potatoes. Prairie Potato Conference, 13 pp, Brandon, MB, February.

McKenzie, R.C. 1998. Precision management of potatoes. Alberta Potato Research Meeting. Calgary, AB, February.

McKenzie, R.C. 1998. Precision Agriculture. Brooks Rotary Club, Brooks, AB, March.

Mirza, M. 1998. Greenhouse Production of Bedding Plants. Presented at Bedding Plants Workshop, Lethbridge, AB, January 27.

Murray, C.L. 1998. Nursery Research Trials. Alberta Horticultural Congress. Edmonton, AB, November.

Najda, H.G. 1998. Grass seed production opportunities. Dynagra Producer Seminar, Rolling Hills, AB.

Park, R. 1998. Pea variety update. Alberta Pulse Growers Commission Zone 2 Variety and Agronomy Update Meeting, Lacombe, AB. March.

Park, R. 1998. Research resource for Alberta Pulse Growers Commission research meetings. Westlock, AB. March and November.

Park, R. 1998. Pulse and special crop variety and production highlights. Alberta Pulse Growers Commission. Zone 3 and AAFRD plot tour. Namao, AB. July.

Park, R. 1998. Pulse variety and agronomy update. AAFRD plot tour. Westlock, AB. July.

Park, R. 1998. Pea variety and agronomy update. AAFRD and Alberta Pulse Growers Commission. Zone 2 plot tour. Killam, AB. July.

Schaupmeyer, C.A. and P.M. Duplessis. 1998. What's cooking in the Alberta Potato Industry. Special Crops Conference. Edmonton, AB. November 2-3.

Tuckey, K.C.S. 1998. Alberta beekeeping industry. Agricultural Lenders Conference. Olds, AB. June.

Tuckey, K.C.S. 1998. A great 58 minute game. Alberta Beekeepers Association. Edmonton, AB. December.

Younus, M. and M. Mirza. 1998. Greenhouse Production of Bedding Plants. Presented at Bedding Plants Workshop. Edmonton, AB. February 10.

Younus, M. 1998. Fertilizer Injectors. Presented at Injectors Workshop. Edmonton, AB. May 13.

Extension Bulletins, Factsheets and Pamphlets

Blade, S.F. 1998. Factsheets on coriander, dill, caraway, buckwheat, caraway and canaryseed produced through a collaborative effort by the AAFRD Pulse and Special Crops Team.

Calpas, J. and M. Mirza. 1998. The Zen of Greenhouse Peppers.

Lopetinsky, K. and B. Park. 1998. Green Peas: How Are Green Peas Like Malting Barley. Alberta Agri-Fax. Agdex 142/25-1.

McKenzie, R.C. 1998. Irrigation and water use. Submitted to Alberta pea Production Guide. 4 pp.

McKenzie, R.C. 1998. Information on manure content and management was provided to D. Fitzgerald, AAFRD, for Manure Management Guideline.

Mirza, M. 1998. A Summary of Greenhouse Crops Industry in Alberta. CDCN-GP-1.

Mirza, M. 1998. The Making of A Successful Greenhouse Project. CDCN-GP-2.

Mirza, M. and M.Younus. 1998. Reading The Tomato Plant.

Mirza, M. and J. Calpas. 1998. Reading Cucumber Plant.

Najda, H.G., A. Kruger and A. Aasen. 1998. Alberta Regional Forage Variety Testing Program. Annual Report, 65 pp.

Najda, H.G., A. Kruger and A. Aasen. 1998. Western forage variety testing program. Annual Report, 122 pp.

Seymour, N.G. 1998. Guide to establishing a nursery in Alberta. CDCS Pamphlet 98-25.

Woods, S.A. 1998. Attended soil quality workshop and participated on soil quality recommendations in Edmonton, AB, January.

Periodicals and Other Newsletters

Blade, S.F. 1998. Fibre hemp production research: central and northern Alberta. Commercial Hemp Winter, 1998 edition, page 5.

Blade, S.F. 1998. Coriander production. Flower and Herb Growers Association Newsletter, Spring.

Blade, S.F. 1998. Canary seed research in western Canada. Special Crops Product Team Newsletter. Volume 1, Edition 2.

Blade, S.F. and K. Lopetinsky. 1998. New Pulse Cultivars Registered for Prairie Production. Pulse Crop News, Spring.

Blade, S.F. 1998. Report on the First Manitoba Commercial Hemp Pageant. Special Crops Product Team Newsletter, Volume 1, Edition 4.

Bains, P.S. 1998. Leaf and berry spot disease. The Prairie Fruit Journal 5(2):3.

Bains, P.S. and R.J. Howard. 1998. PID scientists find effective control for destructive saskatoon disease. Kernels vol 1, issue 5.

Calpas, J. 1998. Assessing first confirmed report of pepper mild mottle virus in Alberta. Greenhouse Canada, October, pp 60-61.

Calpas, J., M. Mirza, K. Pruski, M. Younus, P. Coté, S. Graham. 1998. Greenhouse Coverings. Original monthly newsletter. A full list of titles available at http://agric.gov.ab.ca

Chang, K.F., R.J. Howard, S.F. Blade and S.F. Hwang. 1998. Status of research on ginseng diseases in Alberta in 1998. Alberta Ginseng Association Ginseng Newsletter, December issue, p.1.

Feddes-Calpas, J. 1998. Alberta Dutch Elm Disease Update. Important Forest Pest Conditions, Pest Management Operations and Field Experiments in Alberta. Alberta Land and Forest Service, November.

Feddes-Calpas, J. 1998. Society to Prevent Dutch Elm Disease STOPDED News. Contributions.

Hausher, L.G. 1998. Fruit Facts Bulletin. CDCS. ed. monthly.

Hausher, L.G. 1998. AMGA Newsletter. Contributions - five/year.

Hausher, L.G. 1998. The Prairie Fruit Journal. Contributions (and technical advisor) - four/year.

McKenzie, R.C. 1998. Now you can map salinity in your fields. *In* Grain News, March 17.

McKenzie, R.C. 1998. Crop losses due to "Hidden Salinity". *In* Salt Shaker, pp 3-6, Spring.

McKenzie, R.H., A. Middleton, E. Solberg, J. DeMulder and H. Najda. 1998. Nitrogen and phosphorus optimize barley silage production. Better Crops, 82(4):22-23.

McMenamin H. and R.C. McKenzie. 1998. Soil test just one clue when fertilizing alfalfa. Grain News, July.

Mirza M. and M. Younus. 1998. Reading The Tomato Plant. Greenhouse Canada, pp 4-5, August.

Mirza, M. 1998. When Plants Grow, So Do The Problems. AGGA Newsletter, Summer issue.

Mirza, M. 1998. Guidelines For Growing Leafy Herbs in Greenhouses. AGGA Newsletter, Spring issue.

Murray, C.L. 1998. Fertilizing container-grown plants. Prairie Landscape Magazine, Oct/Nov: 31-34.

Murray, C.L. 1998. Fertilizing container-grown plants in Alberta. Kernals, December.

Najda, H. 1998. New program targets grasses with potential. Seed Scoop, pp. 4, September.

Tuckey, K.C.S., D.A. Colter. 1998. Alberta Bee News. Contributions - 12/year.

Younus, M. and M. Mirza. 1998. How Some Alberta Geranium Growers Dealt with Bacterial Blight last Spring. Greenhouse Canada, pp 24-31, February.

In Agri-News:

Bains, P.S. 1998. Control of leaf and berry spot disease. May 11, 1998, p 3-4.

Bains, P.S. 1998. Leaf and berry spot disease of saskatoon berries. April 6, 1998, p 3.

Calpas, J. 1998. Growing strong with the Alberta greenhouse industry. July 13.

Calpas, J. and M. Mirza. 1998. Greenhouse Problems to watch for. September 7.

Calpas, J. 1998. Increased emphasis on greenhouse crops research. November 30.

Feddes-Calpas, J. 1998. Dutch Elm Disease Awareness Week. May 11.

Feddes-Calpas, J. 1998. Safeguarding Alberta's Elms. September 21.

McKenzie, R.C. and S. Barkley. 1998. Crop losses due to hidden salinity. January.

Mirza. M., K. Pruski and J. Calpas . 1998. Greenhouse clean-up. September 7.

Mirza. M. and J. Calpas. 1998. Starting a new greenhouse business. September 14.

Murray, C.L. 1998. Nursery Crops at CDCS - Growing better quality trees and shrubs in Alberta. May.

Books

Blade, S.F. (Editor). 1998. Opportunities and Profits: Special Crops into the 21st Century. Alberta Agriculture, Food and Rural Development, Edmonton, AB. 162 pages.

McKenzie, R.C. and P. Williams. 1998. Influence of irrigation on wheat strength. *In* Wheat Protein Production and Marketing. Editors: D.B. Fowler, W.E. Geddes, A.M. Johnston and K.R. Preston. Published by University of Saskatchewan Extension Press. Saskatoon, SK. 278-280 pp.

Tuckey, K.C.S. 1998. Contributor to Beekeeping in Western Canada, Alberta Agriculture, Food and Rural Development, Edmonton, AB, chapters 6-9.

Staff list

Horticulture and Apiculture Unit

T.R. Krahn, B.Sc., (Ag.), M.Sc., P.Ag.	Director and Unit Leader, CDCS
P. Bains, B.Sc., M.Sc., Ph.D.	Plant Pathology, CDCN
H. Bennypaul, B.Sc.,M.Sc.	Plant Pathology (TS), CDCN
M. Blank, B.Sc.	Greenhouse Crops (TS), CDCN
J. Calpas, B.Sc. (Ag), M.Sc., P.Ag.	Greenhouse Crops, CDCS
W. Chen, B.Sc.	Greenhouse Crops (TS), CDCN
B. Choban, B.Sc.	Vegetable Crops, CDCN
D. Colter, B.Sc.	Apiculture, Falher
P. Coté, Dipl. Grnhs. Tech.	Greenhouse Crops, CDCS
S. Dalpé, B.Sc. Forestry	Fruit Crops, CDCS
S. Demers Collins, B.Sc.	Farmers' Market Administrator, CDCN
P. Duplessis, B.Sc. (Ag.), M.Sc.	Seed Potato Program, CDCN
J. Feddes-Calpas, Dipl. Hort., Journeyman Landscape Gardener	Dutch Elm Disease, CDCS
C. Feth, Dipl. Hort., B.S.A.	Potato Agronomy Program, CDCS
S. Graham, B.Sc. (Botany), Dipl. Grhs Mngt	Greenhouse Crops (TS), CDCS
L. G. Hausher, B.Sc. (Ag.)	Fruit Crops, CDCS
W. Johnson, Dipl. Hort.	Vegetable Crops, CDCS
T. Lewis, B.Sc. (Ag.)	Seed Potato Program, CDCN
C. McIsaac	Vegetable Crops, CDCN
M. Mirza, B.Sc. (Hons.), M.Sc., Ph.D., Dh.t., P.Ag.	Greenhouse Crops, CDCN
J. Motta, B.Sc. (Ag.)	Entomology, CDCN
C. L. Murray, B.Sc. (Ag.), Ph.D.	Nursery Crops, CDCS
T.T. Pheh, Dipl. Ag.	Nursery Crops, CDCN
K. Pruski, B.Sc., M.Sc. (U of A), P.Ag.	Entomology, CDCN
P. Ragan, B.Sc (Ag.), M.Sc., Ph.D.	Vegetable Crops, CDCS
C. A. Schaupmeyer, B.Sc. (Ag.), M.Sc., P.Ag.	Potato Agronomy Program, CDCS
N. G. Seymour, Dipl. Hort.	Nursery Crops, CDCS
L. Stewart, B.Sc. (Ag.)	Seed Potato Program (TS), CDCN
K. Tuckey, B.S.A., B.Ed.	Apiculture, CDCN
B. Vladicka, P.Ag.	Horticulture Development Officer, CDCN
M. Younus, B.Sc., M.Sc.	Greenhouse Crops, CDCN
M. Yu, Dipl. Biotechnology	Plant Pathology, CDCN

Departures

P. Taschuk, Dipl. Bio. Sc.	Plant Pathology, CDCN—April 1998

Changes

T.R. Krahn, B.Sc., (Ag.), M.Sc., P.Ag.	Director & Horticulture Unit Leader, CDCS—to Sept 1998
R.J. Howard, B.S.A., M.Sc., Ph.D., P.Ag.	Director & Horticulture Unit Leader, CDCS—Sept 1998

Forage Unit

S. Wright, Ph.D., P.Ag. ..... Unit Leader, Lacombe Research Centre
A. Kruger, Dipl. Ag. ..... CDCS
H.G. Najda, B.Sc., M.Sc., P.Ag. ..... CDCS

New Crop Development Unit

R.J. Howard, B.S.A., M.Sc., Ph.D., P.Ag. ..... Unit Leader and Plant Pathology, CDCS
C. Bandura ..... Plant Pathology (TS), CDCS
S.F. Blade, B.Sc., M.Sc., Ph.D., P.Ag. ..... Special Crops, CDCN
M.A. Briant, Dipl. Hort. ..... Plant Pathology, CDCS
K.F. Chang, B.Sc., M.Sc., Ph.D. ..... Plant Pathology, CDCS
N.F. Clark, Dipl. R.R.T. ..... Special Crops, CDCN
L.R.J. Dowdell, B.Sc., M.Sc. ..... Food Science Technology, CDCS
R. Esau, B.S.A., M.Sc., P.Ag. ..... Weed Science, CDCS
L. Hingley, B.Sc. ..... Soil & Water Agronony , CDCS
J.D. Holley, B.Sc., M.Sc., Ph.D. ..... Post-Harvest Technology, CDCS
B.E. Kruger, Dipl. Agr. ..... Weed Science, CDCS
S.I. Lisowski, Dipl. R.M.T. ..... Post-Harvest Technology (SW), CDCS
R.C. McKenzie, B.S.A., M.Sc., Ph.D., P.Ag. ..... Soil and Water Agronomy, CDCS
L.M. Ost, Dipl. Ag. ..... Special Crops, CDCS
R.J. Park, B.Sc. Ag. Sci. ..... Special Crops, Lacombe
E.A. Russell, Dipl. Hort. ..... Special Crops, CDCS
T. Simo ..... Special Crops (TS), CDCS
S. Sims, Dipl. Land Agent ..... Plant Pathology (TS), CDCS
J. Webber ..... Special Crops (SW), CDCS
C.J. Wildschut, Dipl. Hort. ..... Special Crops, CDCS
S.A. Woods, B.Sc., M.Sc. ..... Soil and Water Agronomy, CDCS

Departures

R.G. Gaudiel, B.S.A., M.Sc., Ph.D. — Special Crops, CDCS—Retired, August 1998
J.A. Panford, B.S.A., M.Sc., Ph.D. — Food Science Technology, CDCS—Resignation, June 1998

Changes

S.F. Blade, B.Sc., M.Sc., Ph.D., P.Ag. ... Director & New Crop Development Unit Leader, CDCN—Sept 1998

Support Staff

S.J. Barkley, Dipl. Hort. ..... Information Officer/Librarian, CDCS
S.C. Day ..... Administrative Support (P/PT), CDCS
H. Ellis ..... Administrative Officer, CDCS
P. Fulton ..... Administrative Support, CDCN
L. I. Hansen ..... Officer Manager, CDCN
B.A. Humphreys ..... Receptionist/Timekeeper, CDCS
A. Moeller ..... Accountant, CDCS
C. Moore ..... Administrative Support, CDCN
V. Noel ..... Courier, CDCN
J.P. Petersen ..... Administrative Support/Human Resources, CDCS
C. Pugh ..... Courier (TS), CDCS
M. Tanigami-Bunney ..... Administrative Support, CDCS

Farm and Site Operations

N. Baronasky ..... Lab/Farm Assistant, CDCN
G. Dames ..... Welder, CDCN
G. Feth, Dipl. Hort. ..... Grounds Technologist, CDCS
G. Hooke, Journeyman Landscape Gardener ..... Chemical Applicator & Gardener, CDCN
B. Merkl ..... Mechanic, CDCS
S. Milne ..... Irrigation Technician, CDCN
B. Petherbridge ..... Maintenance Service Worker, CDCN
R. Williams ..... Senior Mechanic, CDCS
W. Wise ..... Farm Manager, CDCS

Arrivals
G. Hooke, Journeyman Landscape Gardener ..... Chemical Applicator & Gardener, CDCN—April 1998

Meteorological Report

N.G. Seymour (CDCS) and T.T. Pheh (CDCN)

The Alberta Agriculture, Food and Rural Development's Crop Diversification Centre South (CDCS) operates two automated weather stations; one at the Centre southeast of Brooks and another at the sub-station southwest of Bow Island.

Brooks (CDCS)

Precipitation is measured with two instruments at the Brooks station. The Tipping Bucket Rain Gauge (TBRG) very accurate in reading rainfall to 0.2 mm is not reliable for recording snowfall. The Fischer-Porter Weighing Gauge (F&P) provides an accurate reading for snowfall equivalent.1998 was a very dry year with an annual precipitation about two thirds of the thirty year average.

The final spring frost of 1998 occurred on June 3 (-0.2°C). The first autumn frost was -2.2°C on October 4, giving a total of 123 frost-free days in 1998. This is higher than the 30-year average (1951-80) of 116 frost-free days (May 21 to September 15).Before the slight frost on June 3, the last frost was May 6 when the temperature went down to -1.2°C.

	Temperatures (°C)								Precipitation (mm)			
	Extremes		Average				Means		1998			1961-90
	Max	Min	Max	30 yr av	Min	30 yr av	1998	30 yr av	TBRG		F&P	30 yr av
January	10.5	-38.1	-8.9	-6.9	-21.4	-23.6	-15.1	-12.5	n/a		4.8	18.4
February	14.8	-16.1	5.2	-2.4	-8.2	-13.9	-1.5	-8.2	n/a		0.7	11.9
March	16.1	-20.6	2.8	3.1	-9.2	-10.6	-3.2	-2.7	n/a		26.4	17.0
April	25.5	-4.8	15.5	12.2	-0.4	0.7	7.9	5.1	13.8		12.6	26.9
May	29.7	-1.2	22.3	18.7	5.2	3.5	13.7	11.4	20.8		20.2	39.1
June	29.2	-0.2	21.4	23.0	9.2	9.8	15.3	15.9	100.4		89.4	65.4
July	34.8	7.3	28.6	25.9	13.5	11.8	21.0	18.3	29.8		23.2	38.0
August	36.4	5.4	29.3	25.2	11.6	10.9	20.4	17.5	8.8		6.1	36.3
September	36.0	1.1	22.8	18.9	7.3	5.8	15.0	11.6	16.0		13.1	38.8
October	25.0	-6.3	14.7	13.6	-0.7	-1.4	7..0	6.3	5.0		6.7	15.8
November	14.5	-14.2	3.8	2.1	-5.4	-13.3	-0.8	-3.7	n/a		3.5	14.9
December	14.0	-32.4	-1.4	-4.6	-14.7	-21.3	-8.0	-10.3	n/a		6.3	18.4
Average	23.9	-10.0	13.0	10.7	-1.1	-2.6	6.0	4.1	Tot.	n/a	213	341

Bow Island (Sub-station)

The last recorded frost was -0.4°C on May 6 and the first autumn frost (-1.0°C) occurred on October 4, for a total of 151 frost-free days in 1998, much greater than the 30-year average (1951-80) growing season at Bow Island of 125 days (May 17 to September 20).

It is important to note that precipitation is only measured with a tipping Bucket Rain Gage which is unreliable during the winter months.

	Temperatures (°C)								Precipitation (mm)		
	Extremes		Average				Means		1998		1961-90
	Max	Min	Max	30 yr av	Min	30 yr av	1998	30 yr av	TBRG		30 yr av
January	9.4	-36.9	-6.5	-5.2	-17.8	-15.9	-12.2	-10.6	2.8		18.6
February	14.1	-16.7	5.9	-6.3	-6.4	-11.7	-0.3	-6.3	0.3		11.3
March	14.6	-19.8	2.7	4.7	-8.3	-6.6	-2.8	-0.9	18.0		13.1
April	25.9	-4.4	14.4	12.5	0.9	0.2	7.6	6.6	11.7		34.2
May	28.9	-1.4	21.1	19.2	5.9	5.5	13.5	12.4	35.6		44.9
June	25.9	1.1	19.3	24.4	8.4	10.7	13.9	17.6	129.3		69.8
July	33.3	6.6	27.2	27.6	12.7	12.1	20.0	19.7	16.5		30.9
August	34.9	5.4	29.0	27.1	11.3	11.9	20.2	19.6	16.0		32.4
September	34.8	0.9	22.2	20.2	7.7	5.6	15.0	12.9	16.5		30.4
October	24.7	-5.5	14.7	15.0	0.8	0.5	7.4	7.6	6.1		12.3
November	13.3	-13.7	4.5	4.7	-4.1	-6.6	0.2	-1.0	2.3		12.8
December	15.8	-33.2	-1.5	-2.8	-13.0	-13.0	-7.2	-7.9	0.3		19.0
Average	23.0	-9.8	12.8	12.2	-0.2	-0.6	6.3	5.8	Tot.	255	330

Edmonton (CDCN)

	Temperatures °C					Precipitation	
	Extremes		Average		Means		
	Max	Min	Max	Min	1998	Snow (cm)	Rain (mm)
January	8.54	-37.65	-13.01	-23.16	-18.09	27.4	0
February	9.62	-19.12	-0.06	-11.58	-5.82	traces	0
March	14.82	-30.96	1.79	-8.92	-3.57	15.1	0
April	23.59	-5.52	13.97	-0.01	6.98		23.8
May	27.83	-0.70	21.54	6.68	14.11		29.4
June	28.25	0.71	20.63	8.58	14.61		90.7
July	29.78	7.86	24.19	12.14	18.17		61.7
August	33.70	3.52	25.22	11.19	18.21		34.9
September	30.55	-0.63	18.82	4.84	11.83		43.3
October	22.65	-5.65	11.56	.50	6.03		25.1
November	6.20	-20.95	-0.93	-9.78	-5.36	24.0	14.1
December	7.83	-34.73	-6.35	-16.95	-11.65	5.4	3.1
Averages	20.28	-11.99	9.78	-2.21	3.79	14.38	27.2
Total						71.9	326.1

Heat units at CDCN calculated from last to first killing frost.

April	77.54
May	307.35
June	304.12
July	438.66
August	443.68
September	211.88
October	57.51
Total	1840.74

Last killing frost — April 18, 1998

First killing frost — October 23, 1998

Total frost-free days — 188

Killing frost is taken as minus 2° C

Base temperature is 5° C